US011097302B2

(12) **United States Patent**
Anderson et al.

(10) **Patent No.: US 11,097,302 B2**
(45) **Date of Patent: Aug. 24, 2021**

(54) **TIRE DRESSING MACHINE AND APPLICATION METHOD**

(71) Applicant: **Howco, Inc.**, Charlotte, NC (US)

(72) Inventors: **Peter J. Anderson**, Raleigh, NC (US); **Charles Andrew Howard**, Charlotte, NC (US)

(73) Assignee: **Howco, Inc.**, Charlotte, NC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/973,942**

(22) Filed: **May 8, 2018**

(65) **Prior Publication Data**

US 2018/0326446 A1 Nov. 15, 2018

Related U.S. Application Data

(60) Provisional application No. 62/504,314, filed on May 10, 2017.

(51) **Int. Cl.**

B05C 1/02 (2006.01)
B05C 21/00 (2006.01)
B60S 3/04 (2006.01)

(52) **U.S. Cl.**

CPC ***B05C 1/02*** (2013.01); ***B05C 21/00*** (2013.01); ***B60S 3/042*** (2013.01); *B60S 3/04* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

1,487,062 A *	3/1924	Hohl	....	B60S 3/04 134/109
2,692,214 A	10/1954	Hurst		
3,208,089 A	9/1965	Vani		
4,550,464 A	11/1985	Messing		
5,309,931 A	5/1994	Meyer		
5,320,121 A	6/1994	Alexanian		
6,383,295 B1	5/2002	Frederick, Jr. et al.		
7,582,164 B1	9/2009	Krause et al.		
2008/0187674 A1*	8/2008	Wentworth	....	B60S 3/042 427/429
2010/0272916 A1	10/2010	Falbaum et al.		
2013/0081569 A1*	4/2013	Wentworth	....	B60S 3/042 118/206

OTHER PUBLICATIONS

International Search Report and Written Opinion of corresponding application PCT/US18/31795, dated Sep. 25, 2018.

* cited by examiner

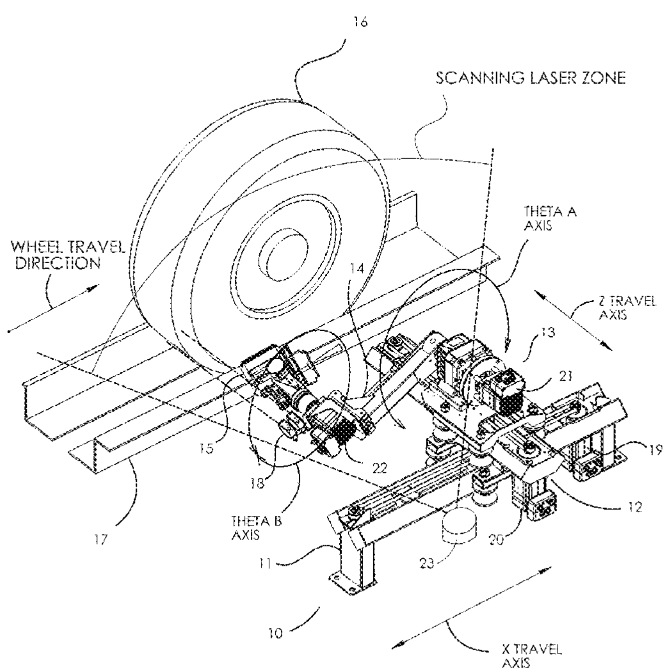
Primary Examiner — Jethro M. Pence

(74) *Attorney, Agent, or Firm* — Nelson Mullins Riley & Scarborough LLP

(57) **ABSTRACT**

A vehicle tire dressing machine comprises a longitudinal linear guide system and a lateral linear guide system. The longitudinal linear guide system is adjacent and parallel to a transport conveyor for a vehicle having a vehicle tire, and the longitudinal linear guide system has a drive motor and is adapted for reciprocal motion thereon.

15 Claims, 22 Drawing Sheets



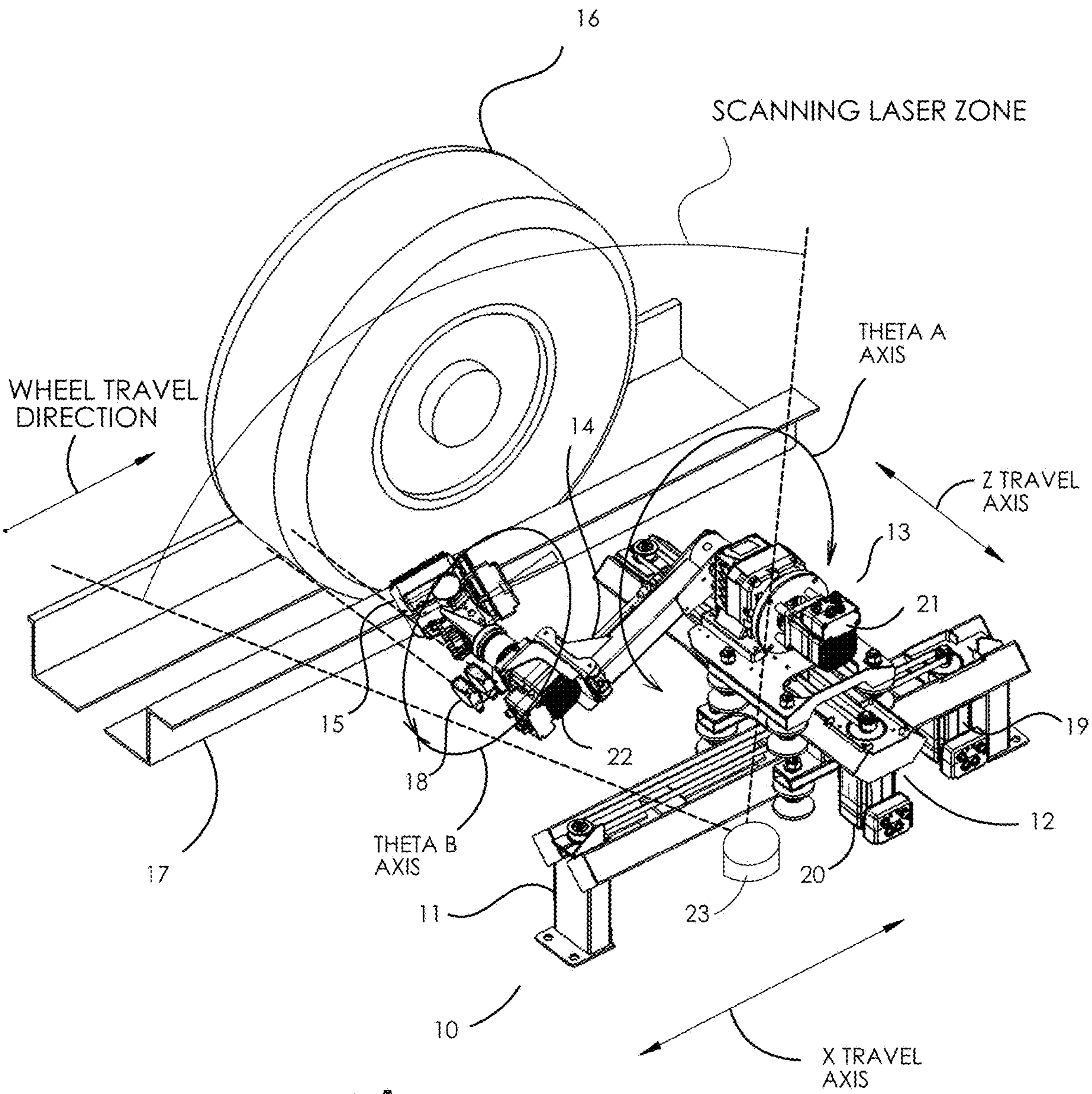

16
SCANNING LASER ZONE
THETA A
AXIS
WHEEL TRAVEL
DIRECTION
14
Z TRAVEL
AXIS
13
21
19
15
22
18
12
THETA B
AXIS
20
17
11
23
10
X TRAVEL
AXIS

FIG. 1

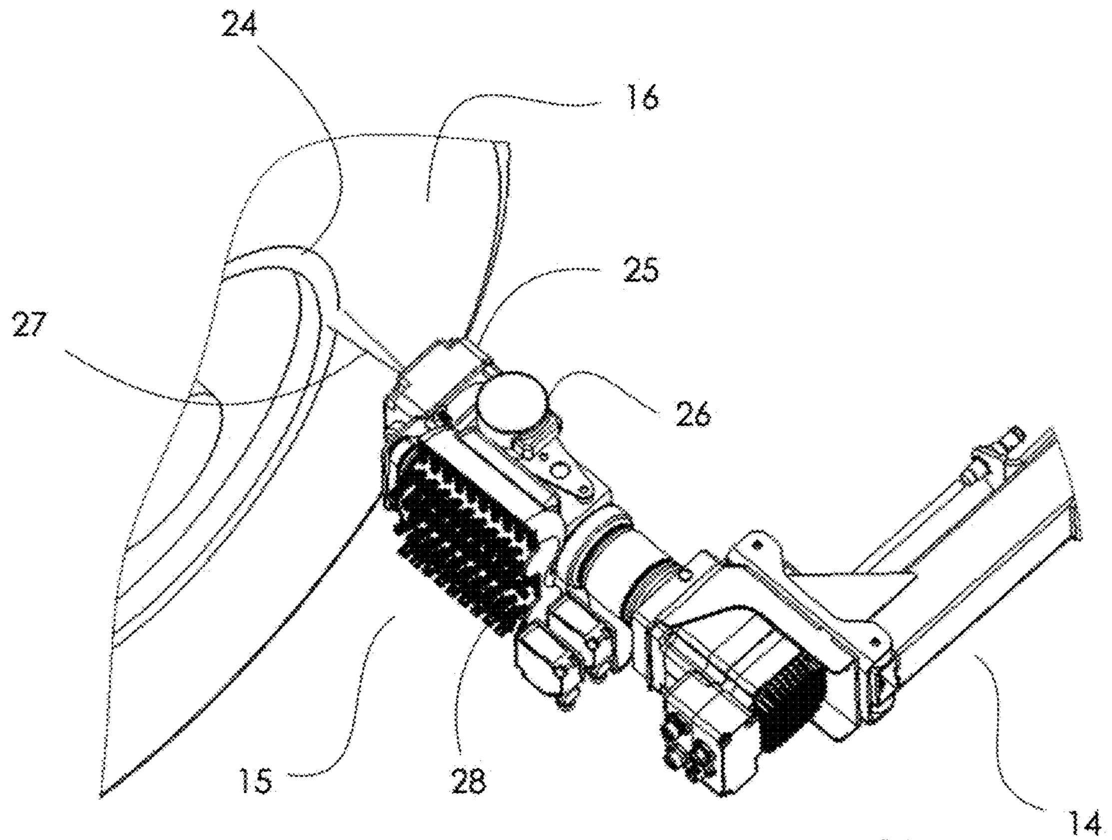


FIG. 2A

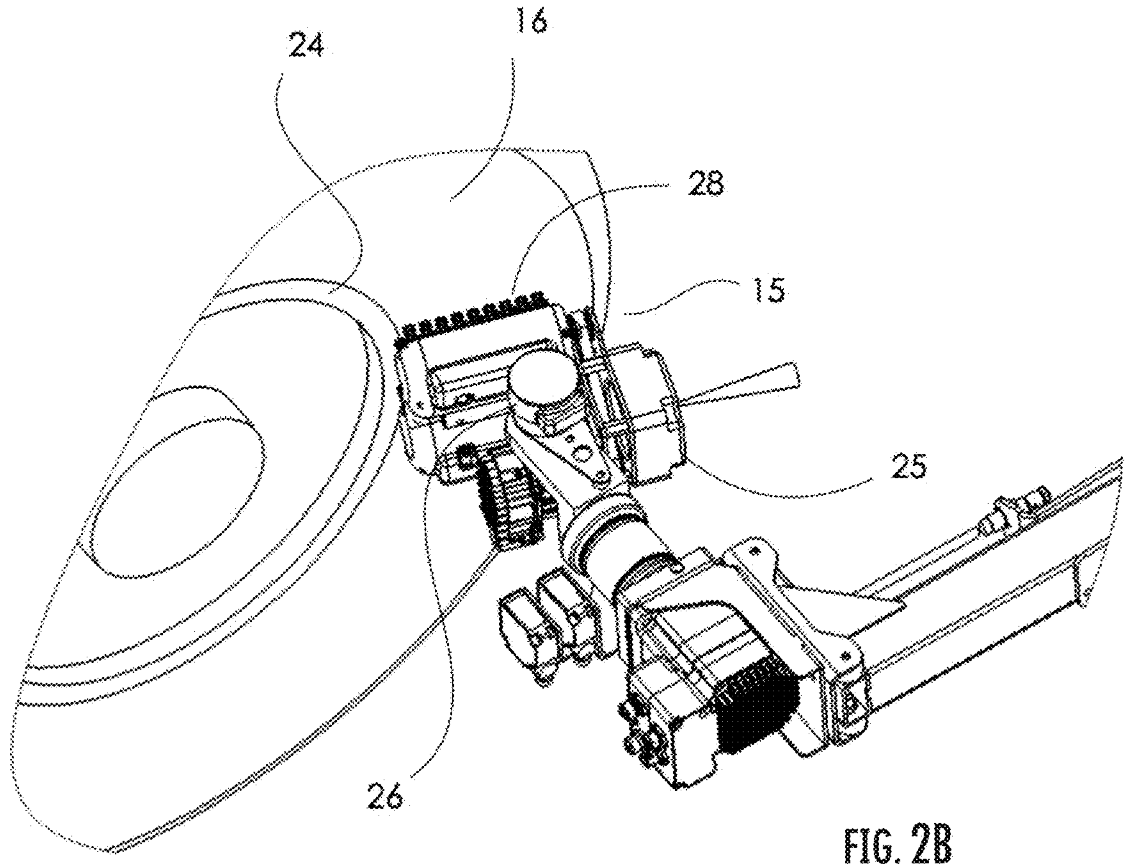


FIG. 2B

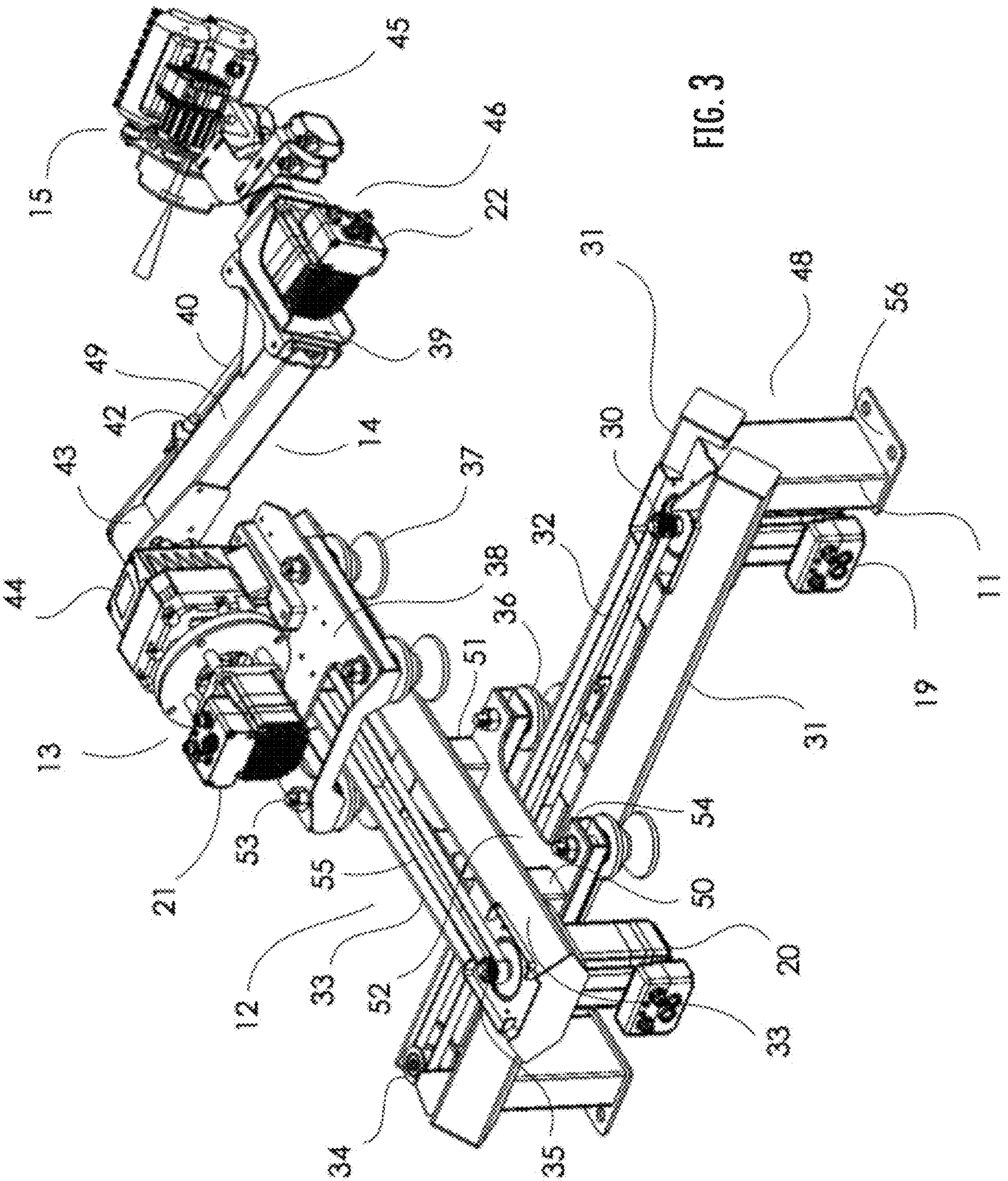

15
45
46
22
40
49
42
39
14
43
37
44
38
36
32
31
30
48
56
11
19
31
51
13
21
53
55
54
50
20
12
33
52
33
34
35

FIG. 3

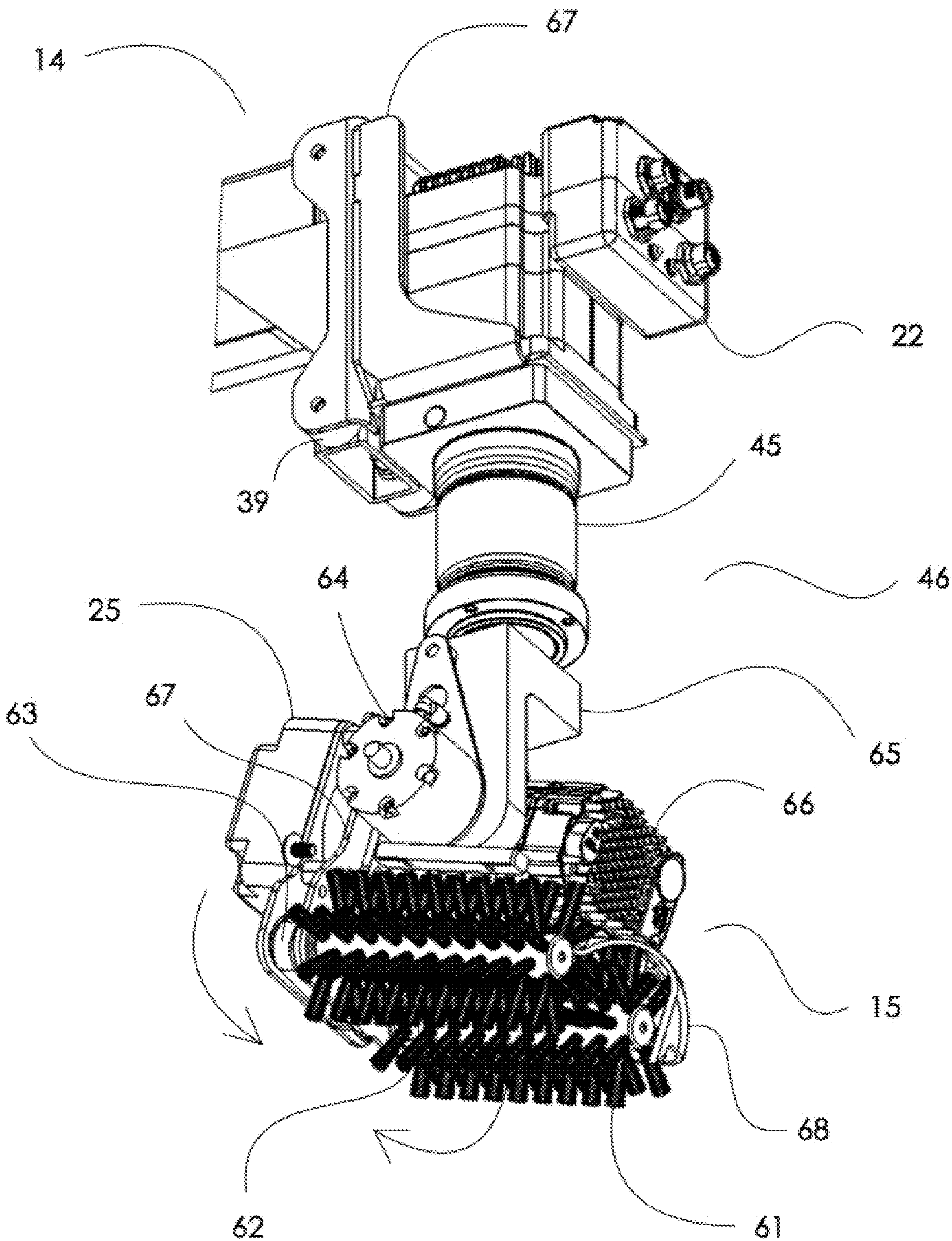


FIG. 4

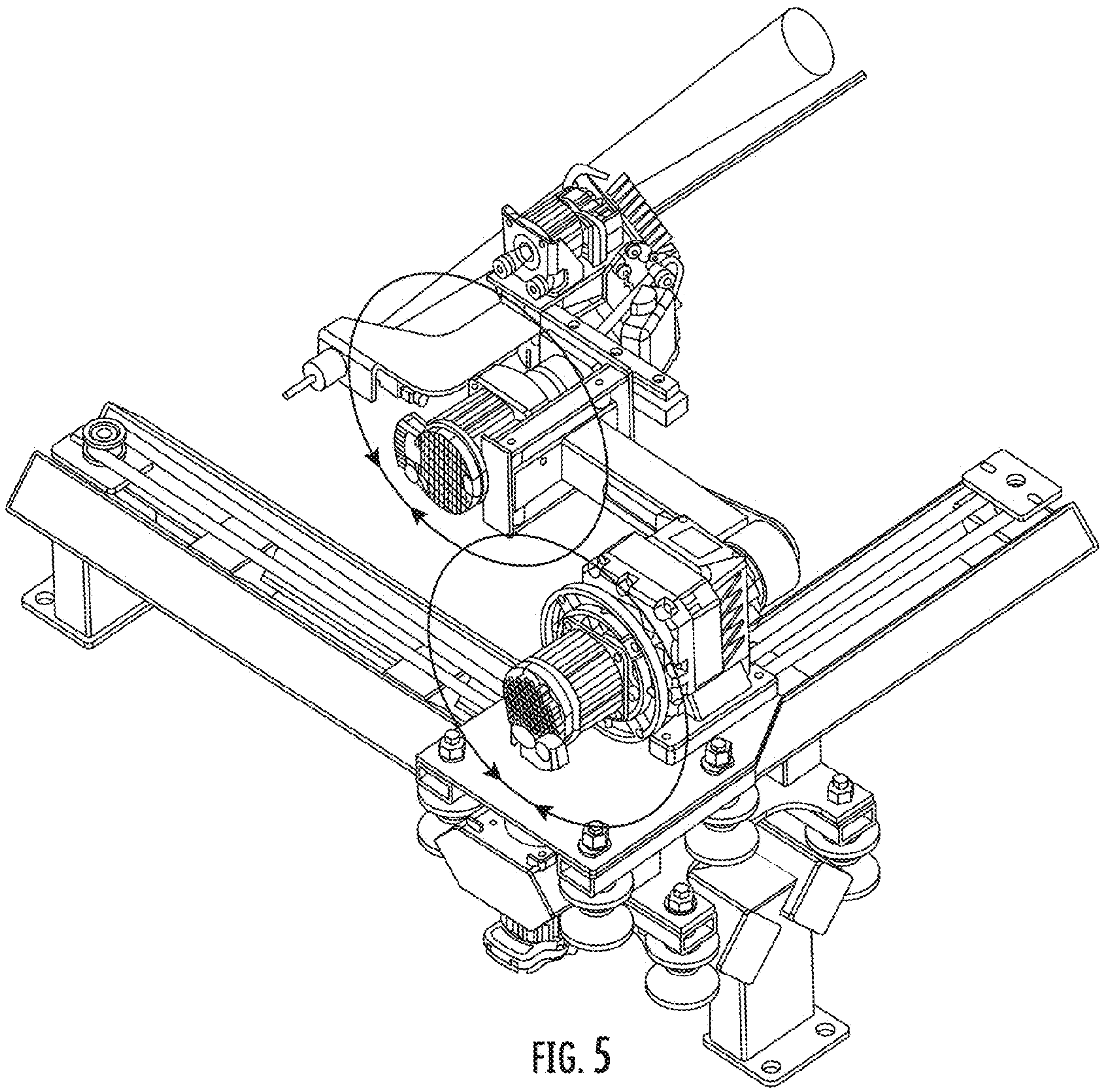


FIG. 5

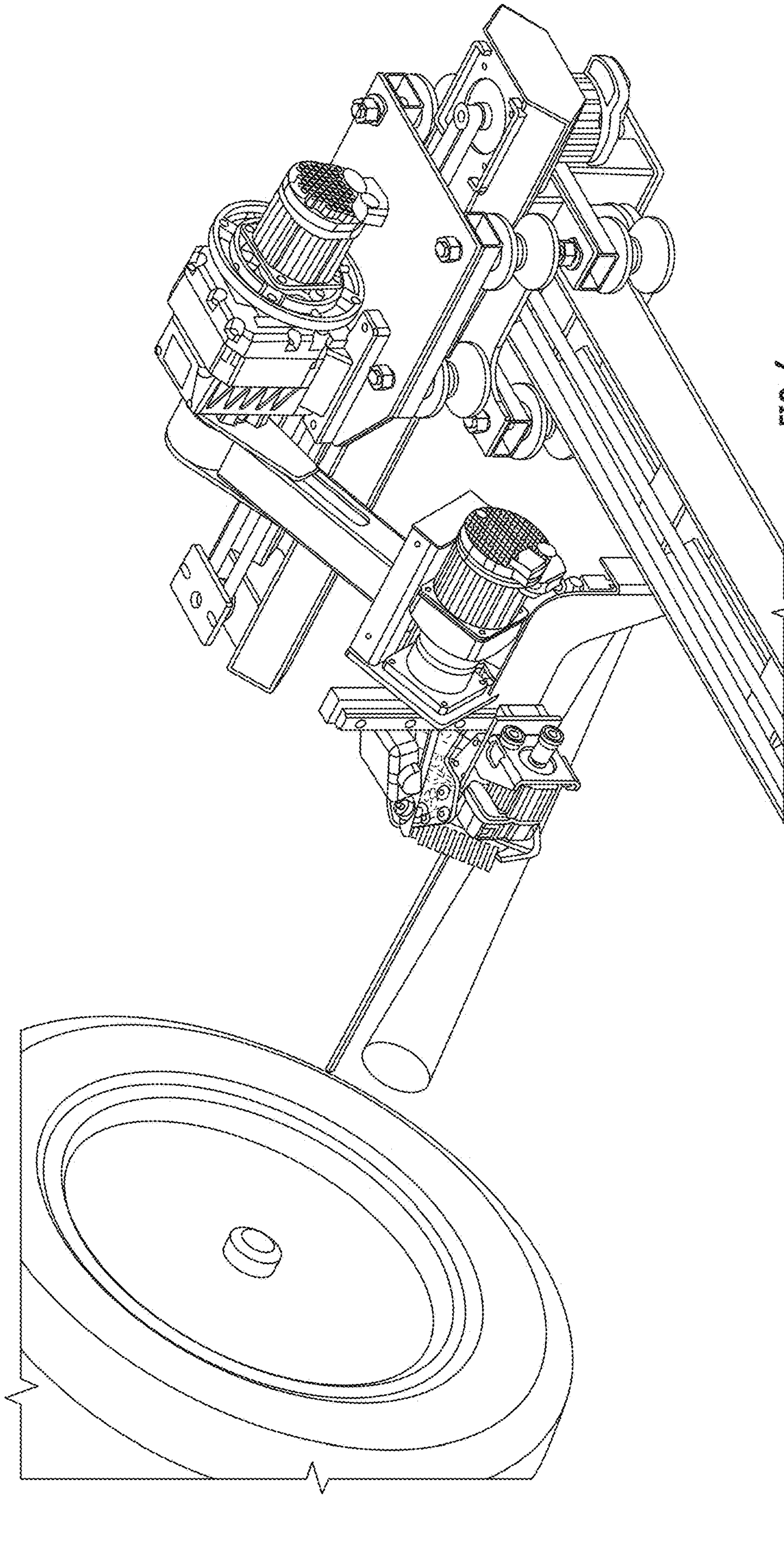


FIG. 6

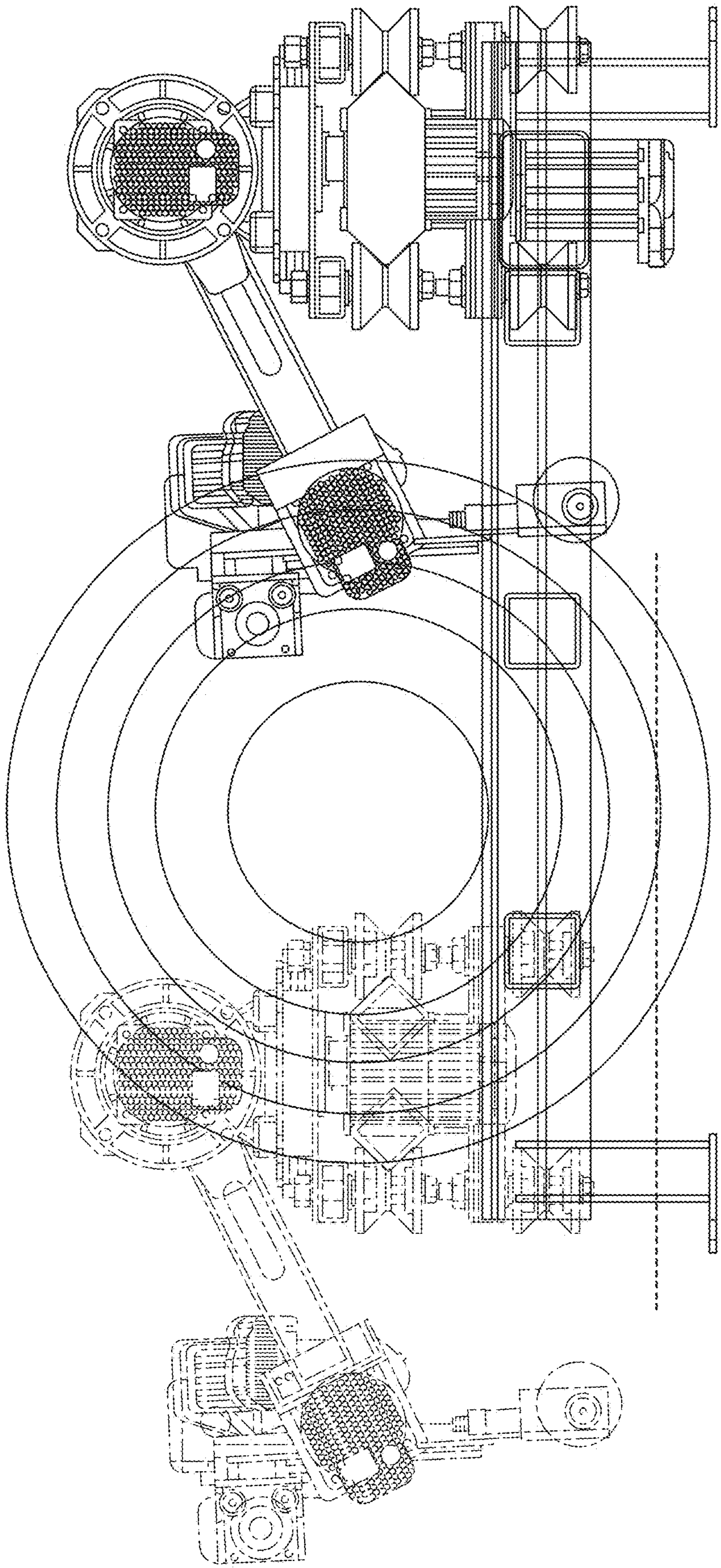


FIG. 7

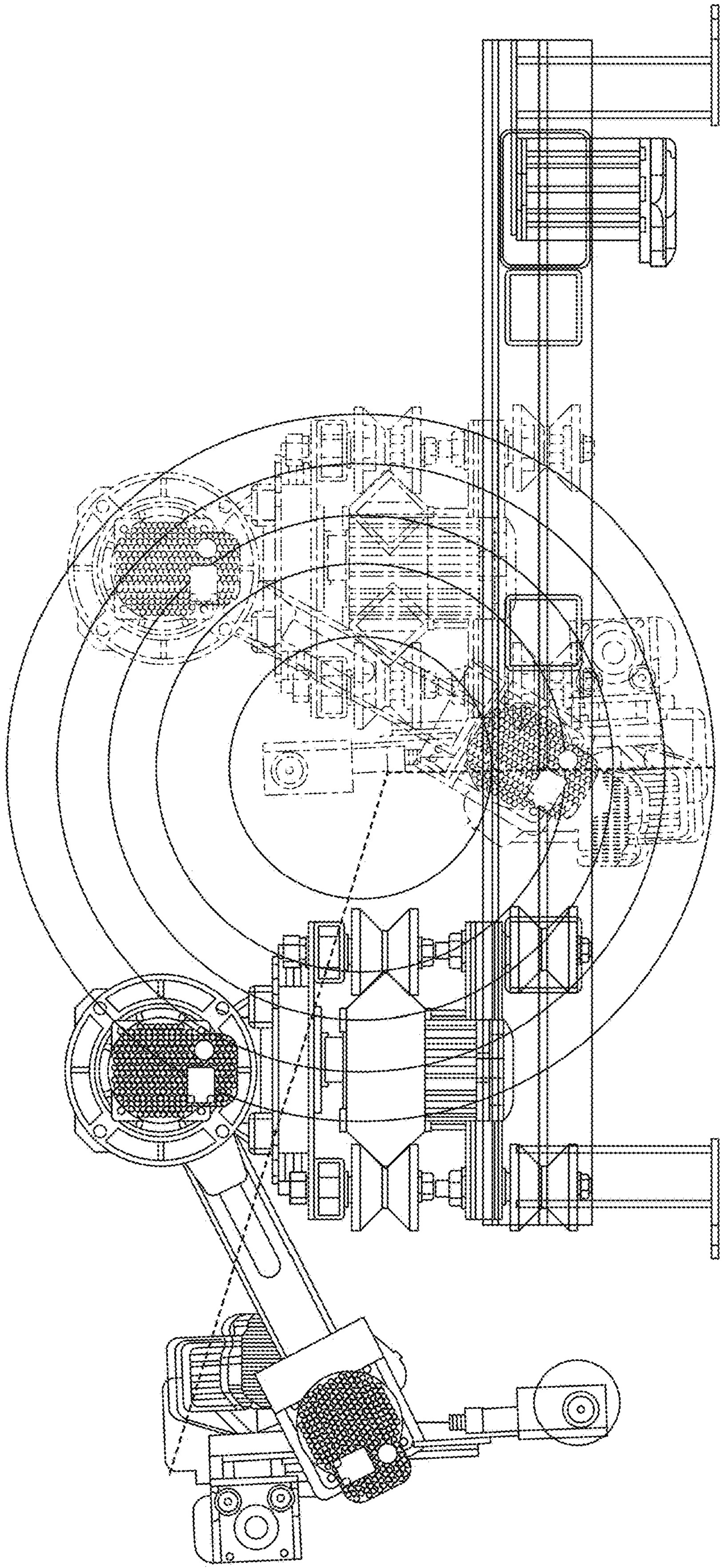


FIG. 8

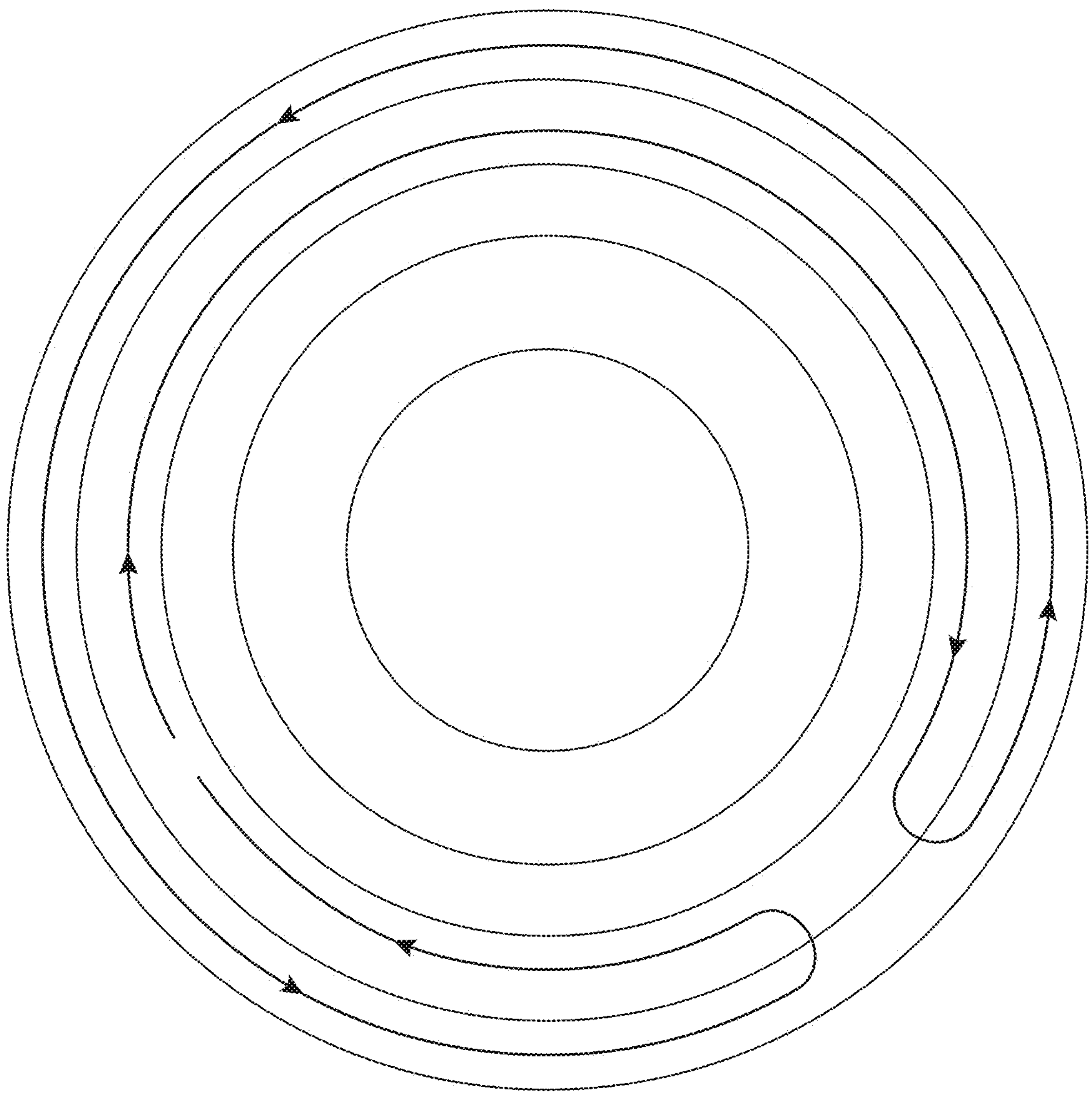


FIG. 9

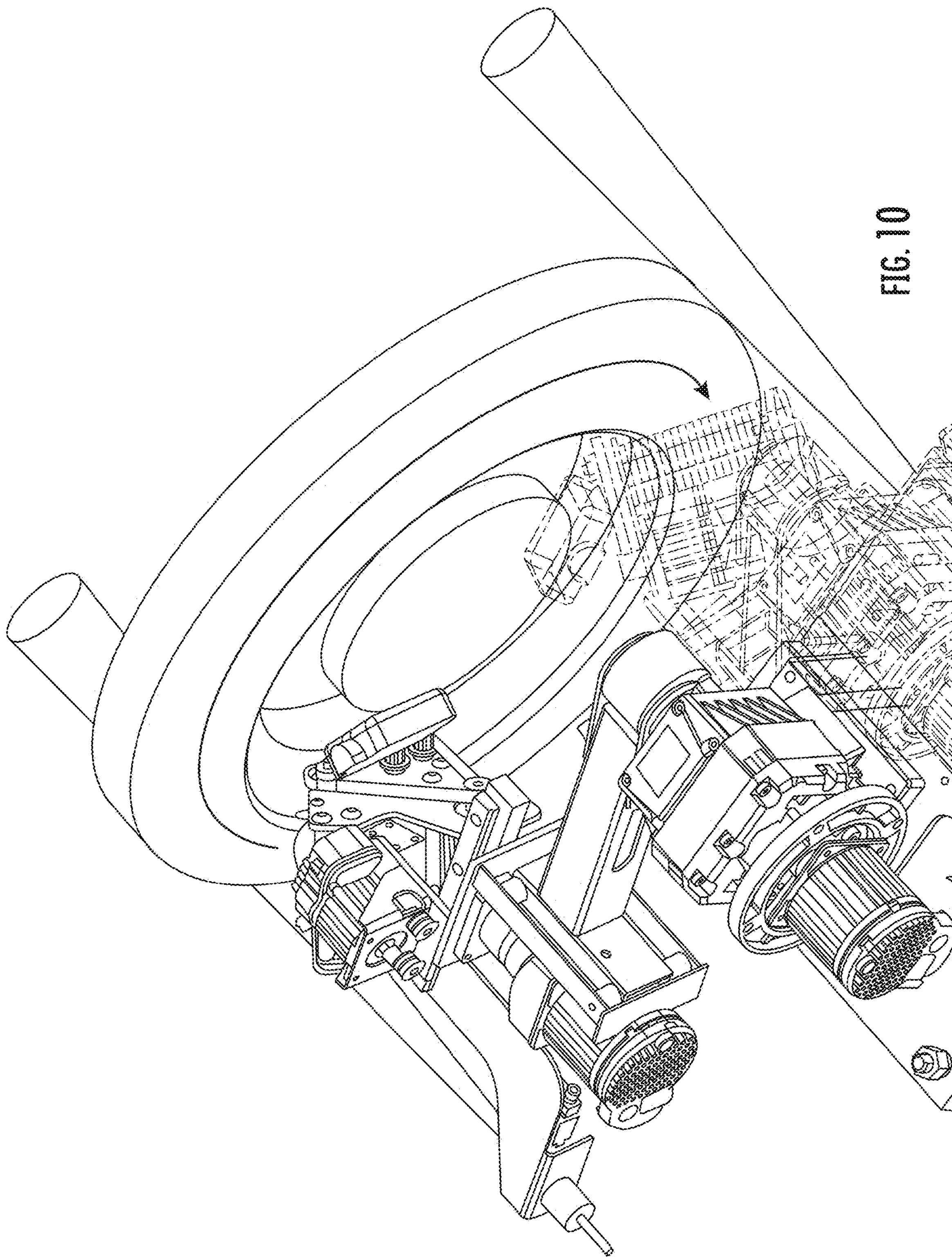


FIG. 10

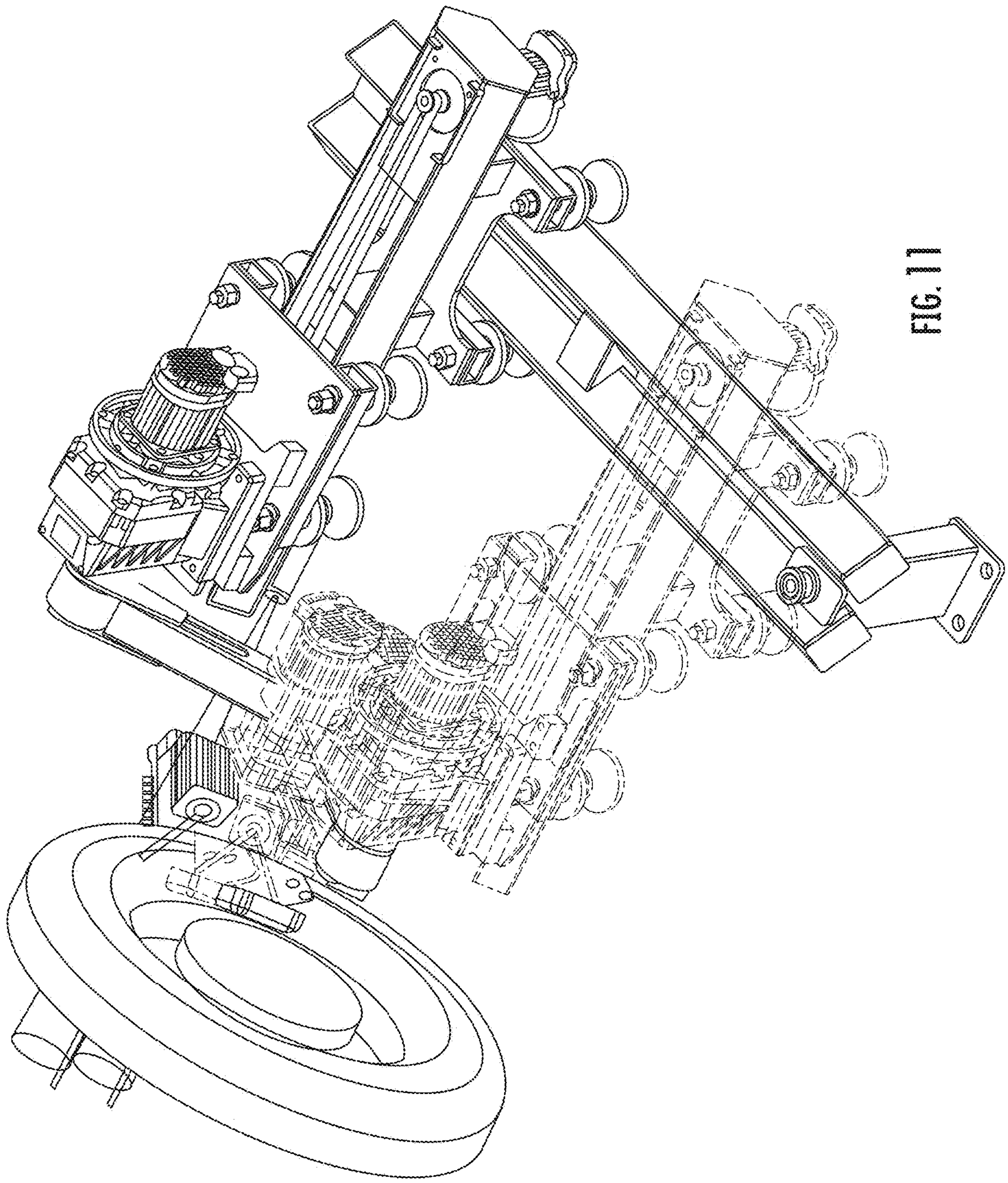


FIG. 11

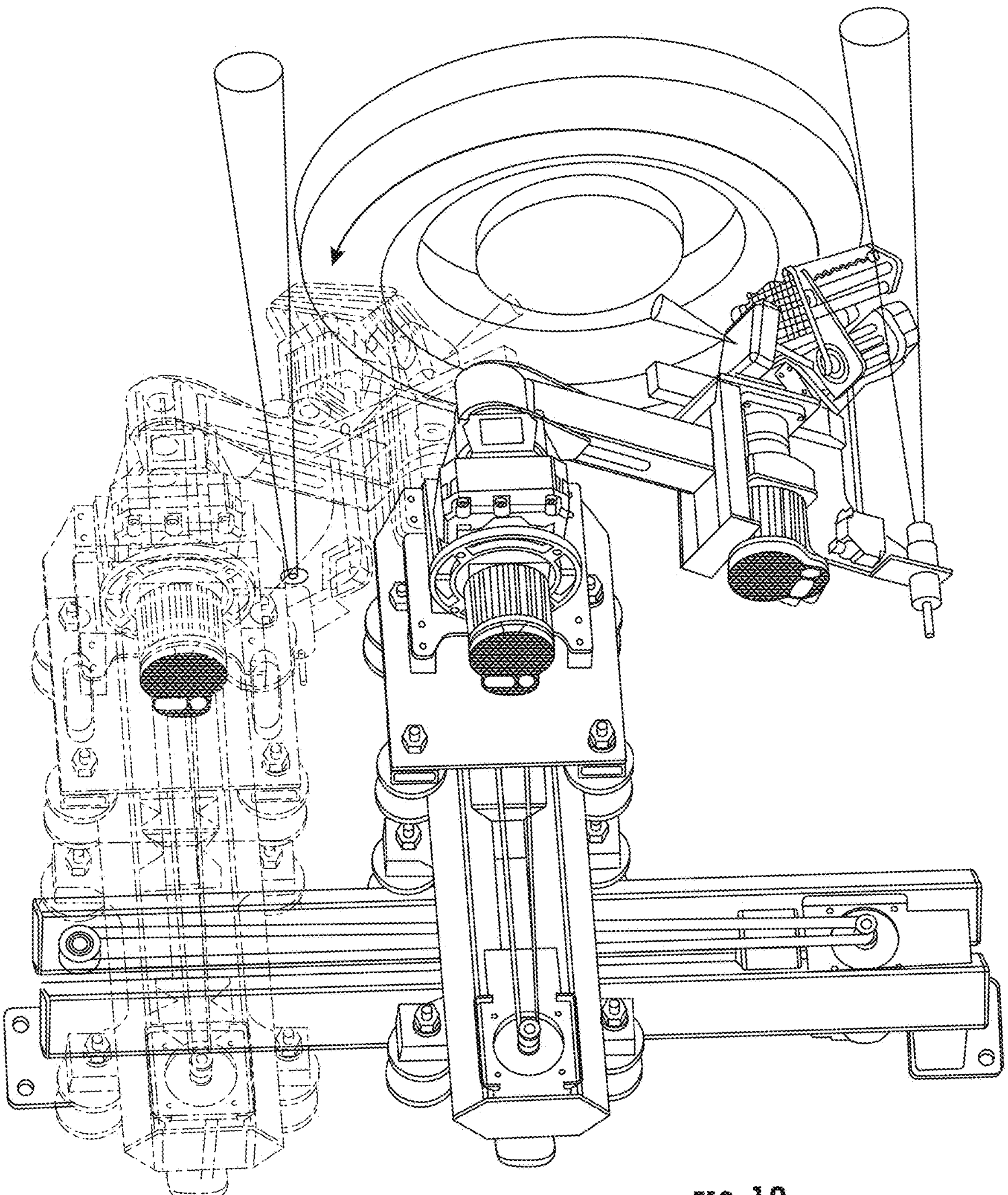


FIG. 12

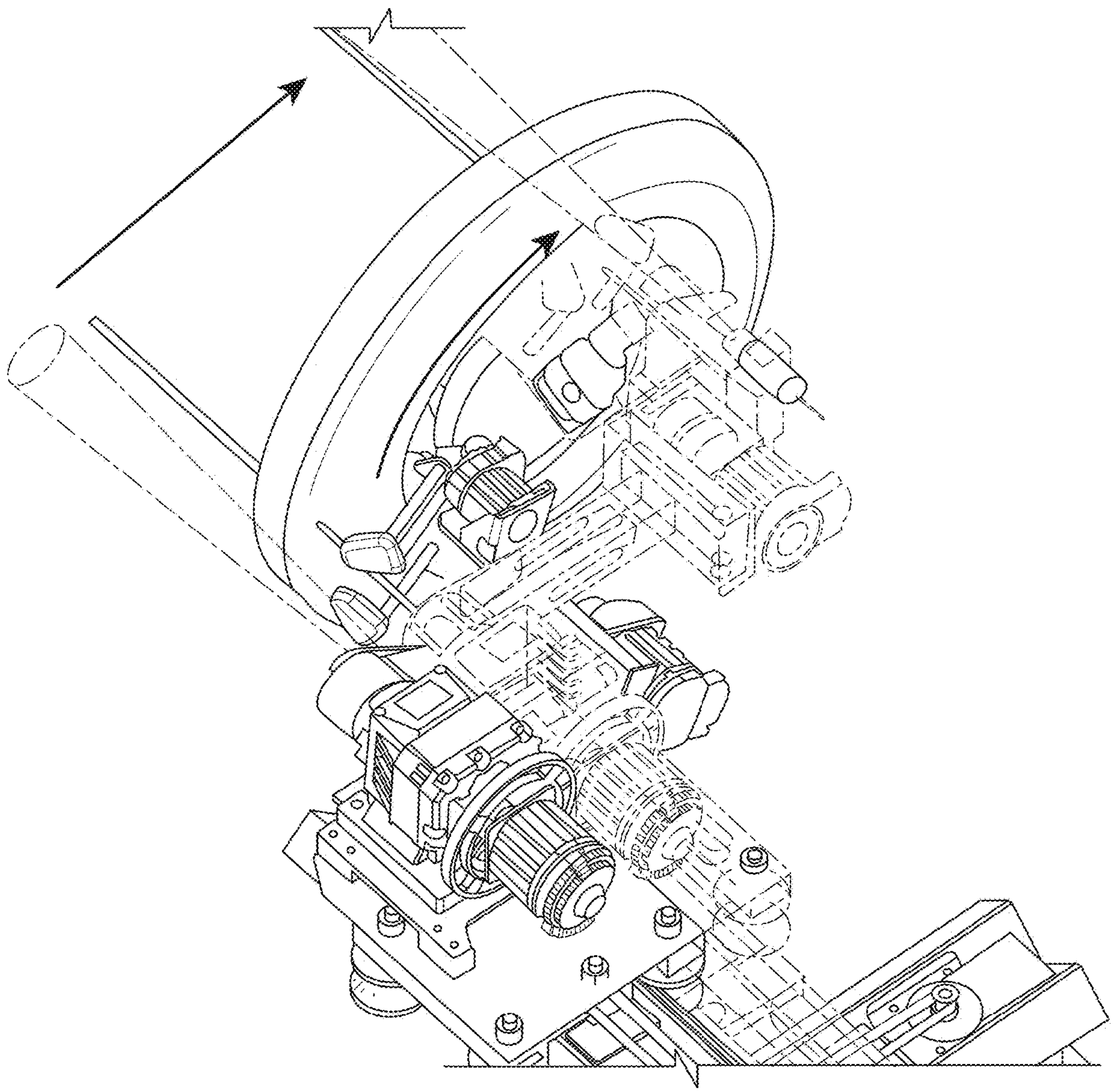


FIG. 13

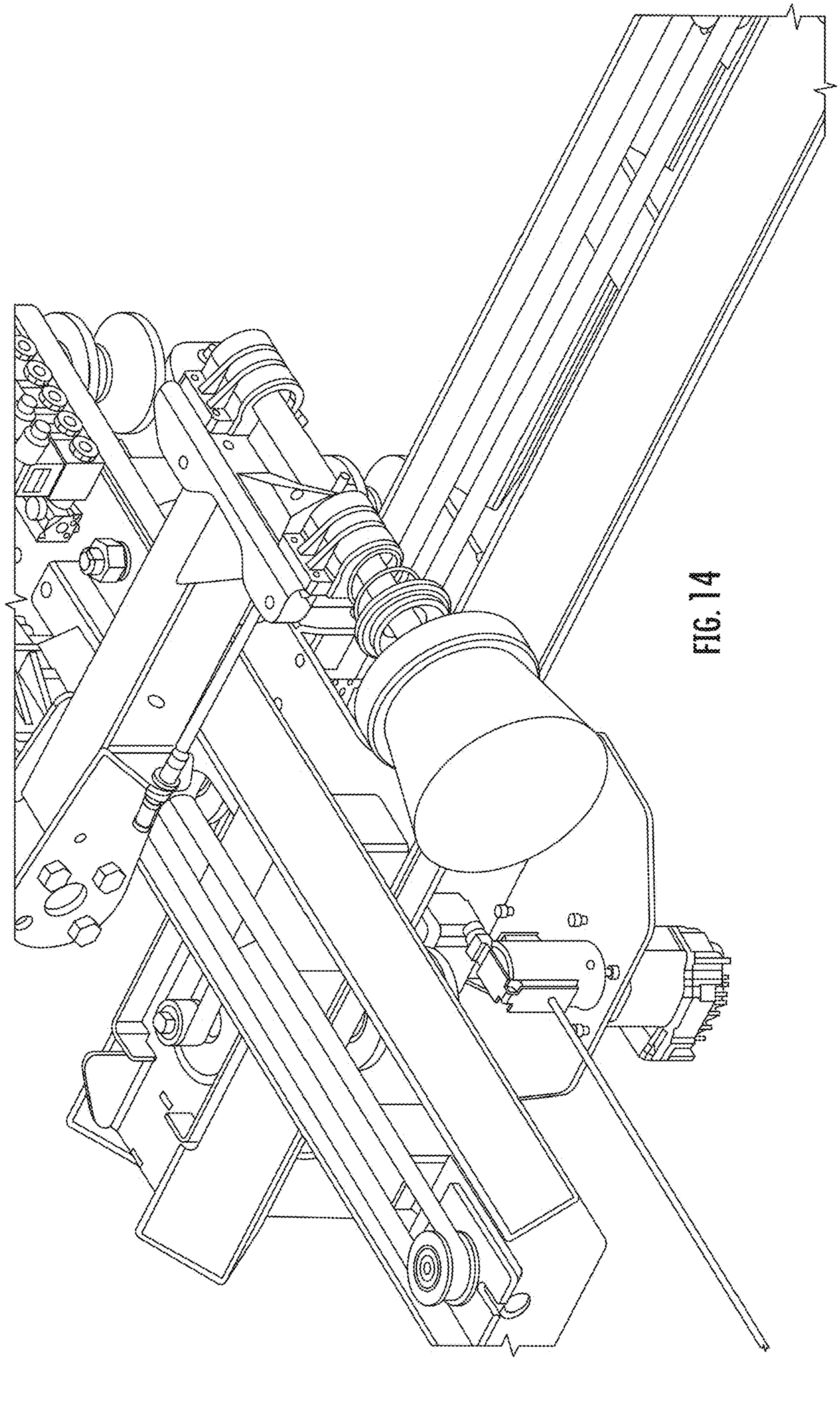
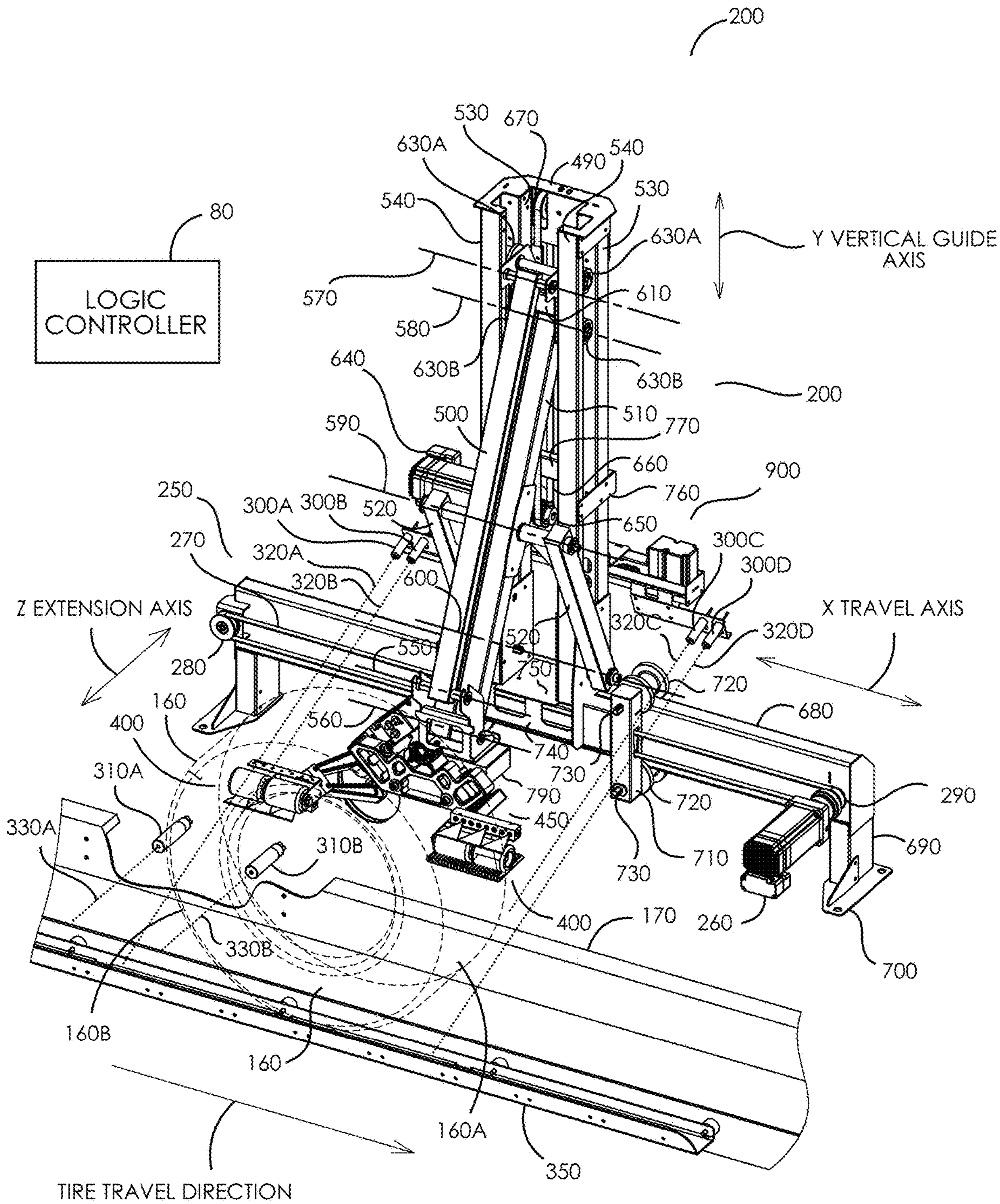


FIG. 14



200
LOGIC CONTROLLER
80
Y VERTICAL GUIDE AXIS
Z EXTENSION AXIS
X TRAVEL AXIS
TIRE TRAVEL DIRECTION
530
670
630A
540
490
570
580
610
630B
640
500
510
770
590
660
760
900
250
300A
300B
520
650
300C
300D
270
320A
320B
600
320C
320D
550
750
720
280
160
560
740
730
680
400
790
450
710
290
310A
310B
330A
690
260
170
330B
700
160B
160A
350

FIG. 15

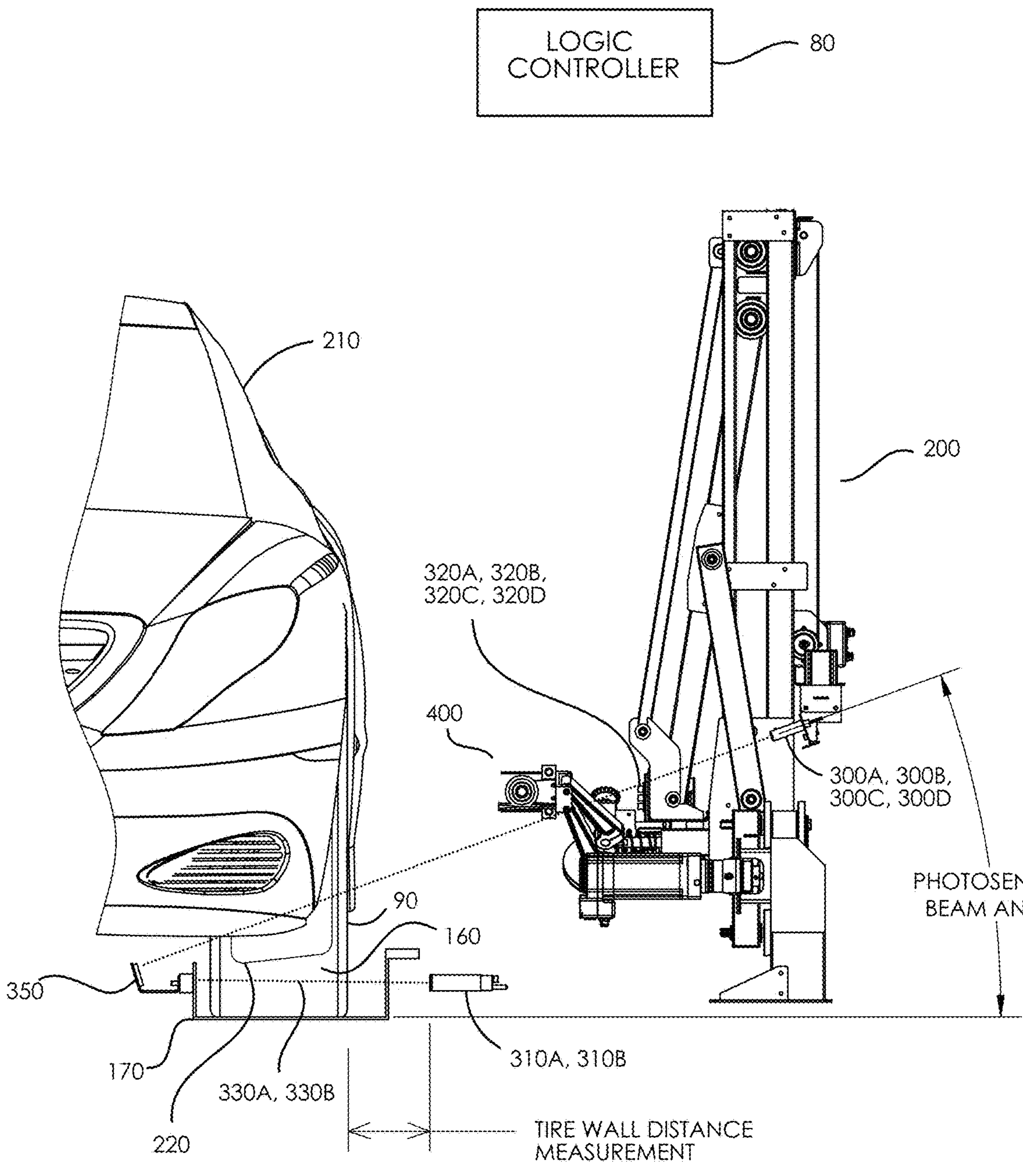

LOGIC
CONTROLLER
80
210
200
320A, 320B,
320C, 320D
400
300A, 300B,
300C, 300D
PHOTOSENSOR
BEAM ANGLE
90
160
350
170
330A, 330B
310A, 310B
220
TIRE WALL DISTANCE
MEASUREMENT

FIG. 16

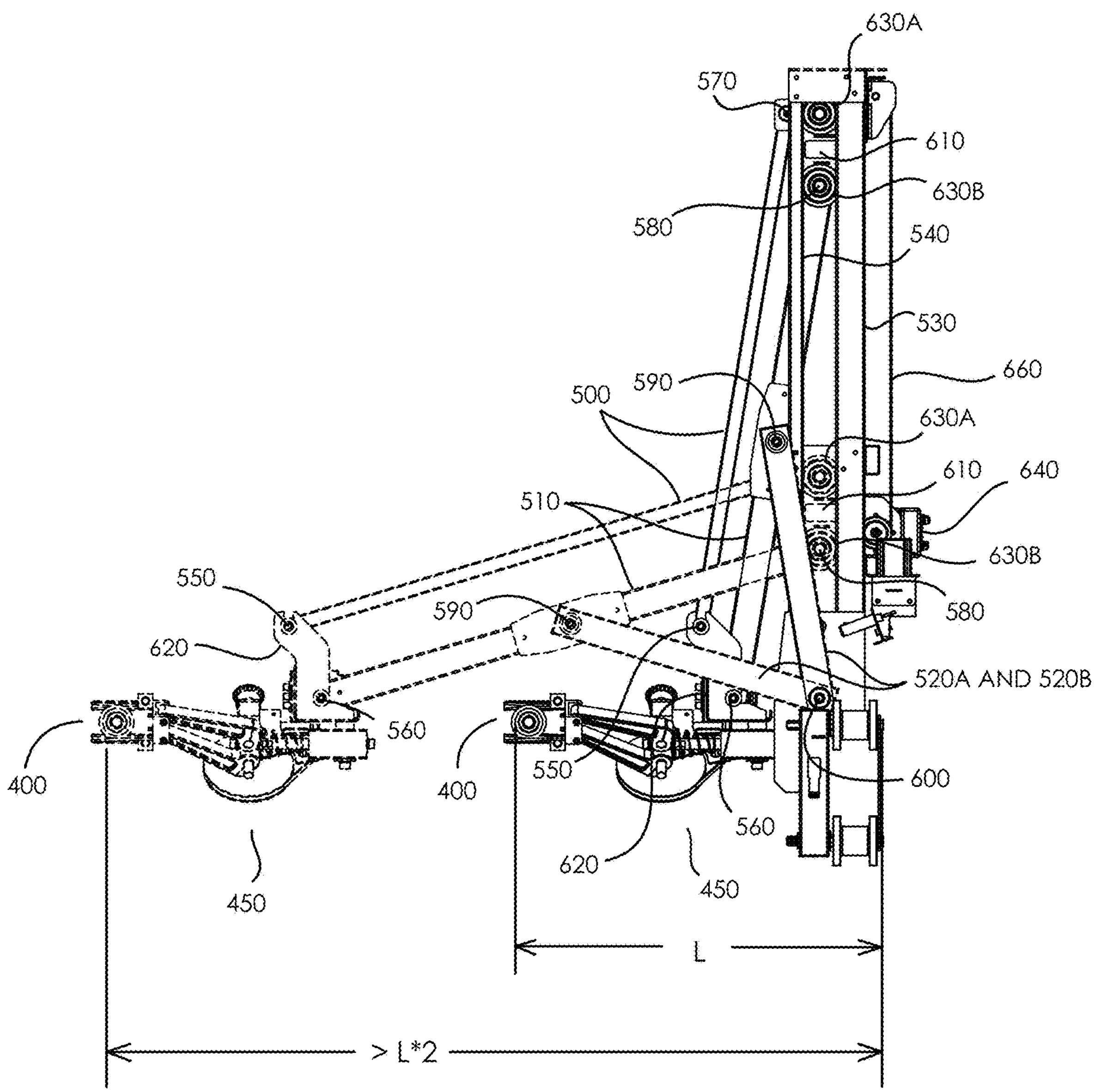

630A
570
610
630B
580
540
530
660
590
500
630A
610
640
510
630B
550
590
580
620
520A AND 520B
560
400
400
550
600
560
620
450
450
L
> L*2

FIG. 17

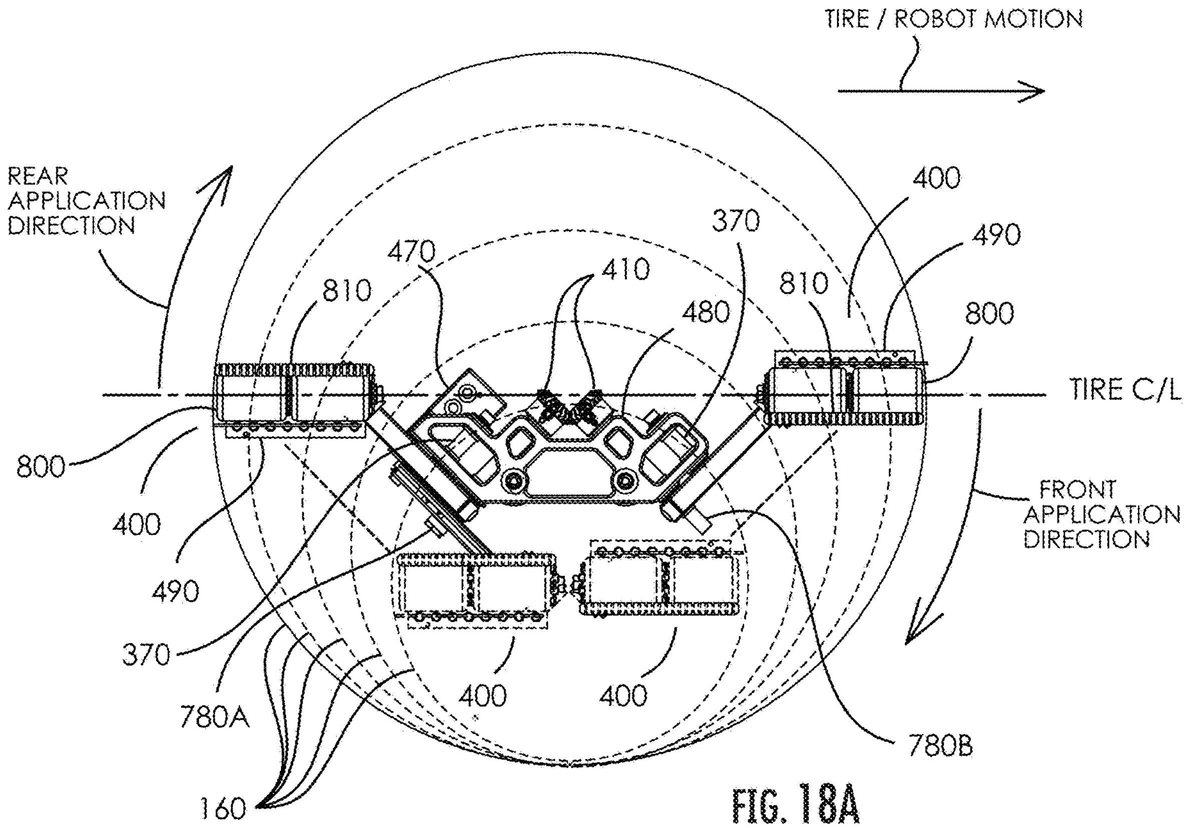


FIG. 18A

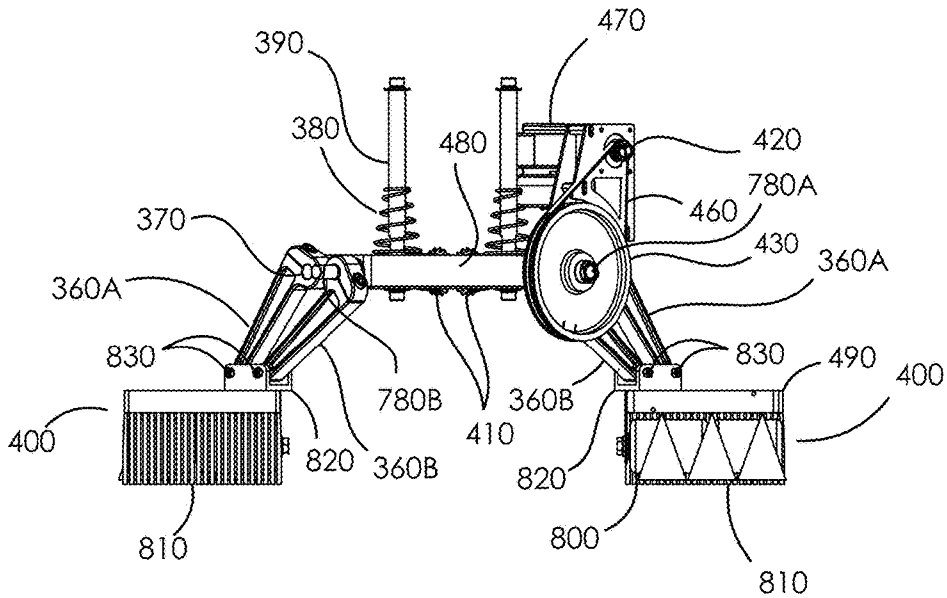


FIG. 18B

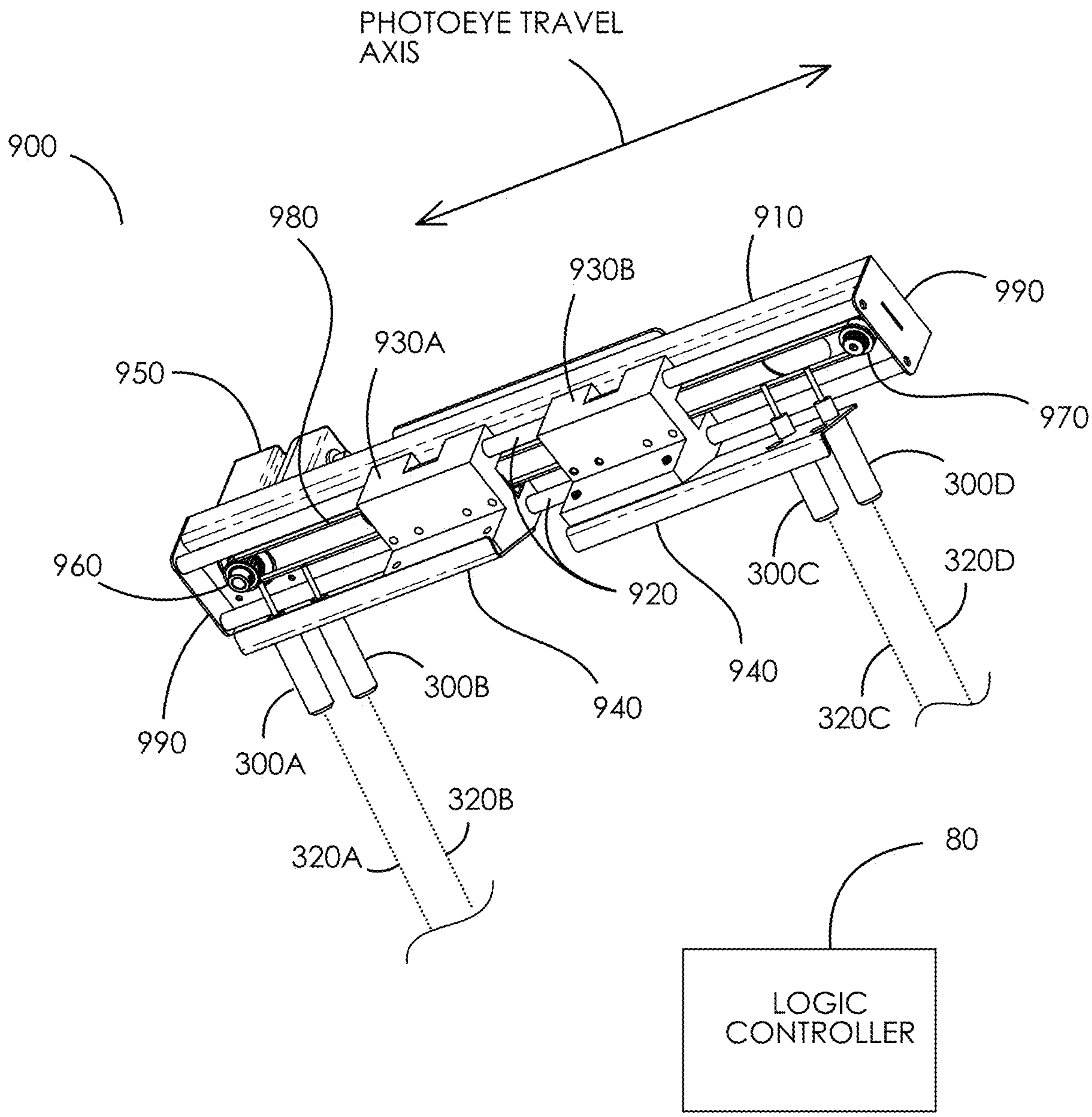

PHOTOEYE TRAVEL AXIS
900
980
910
930B
990
930A
950
970
300D
960
300C
320D
920
940
990
300B
940
320C
300A
320B
320A
80
LOGIC CONTROLLER

FIG. 19

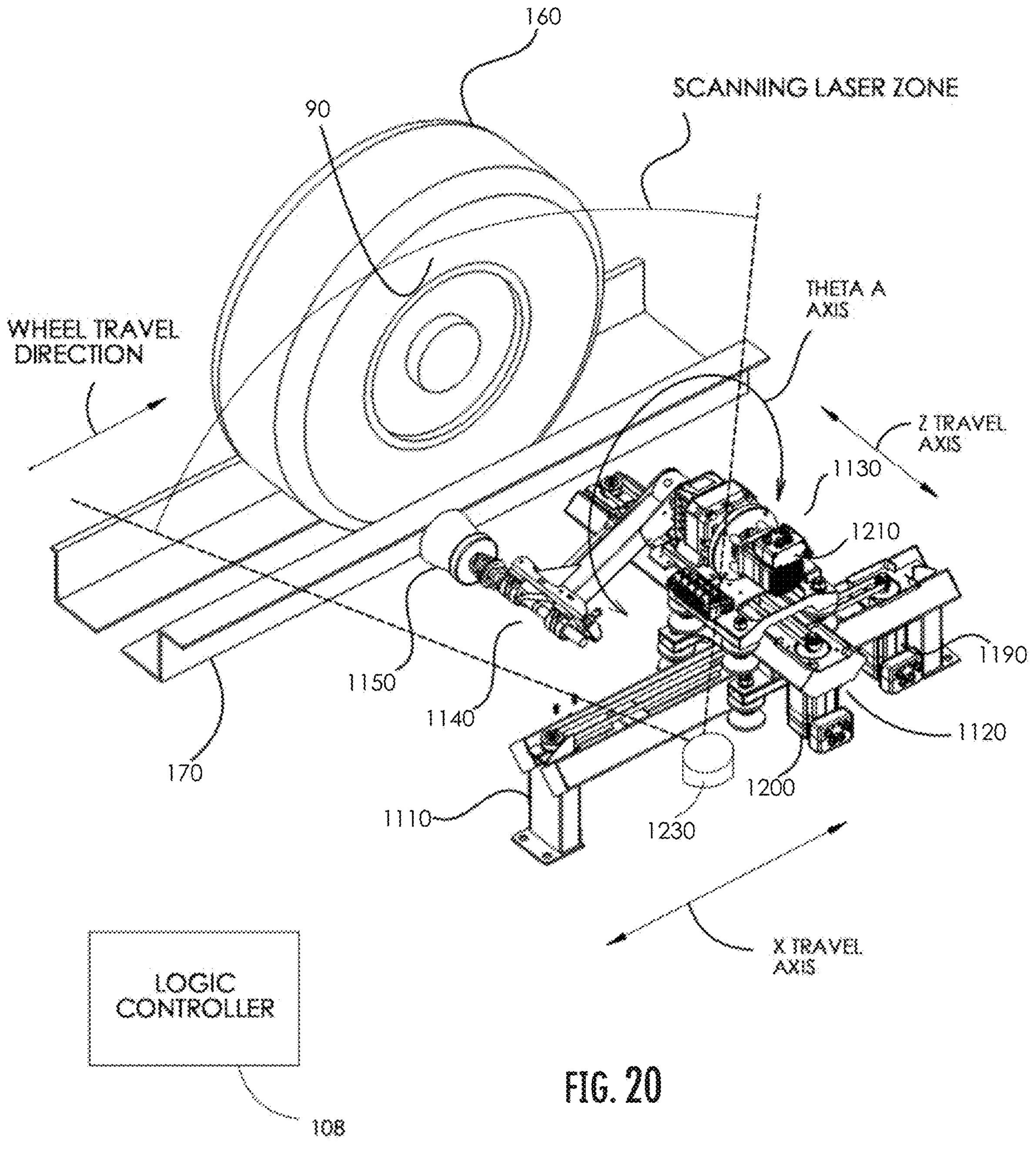

160
SCANNING LASER ZONE
90
WHEEL TRAVEL
DIRECTION
THETA A
AXIS
Z TRAVEL
AXIS
1130
1210
1190
1150
1140
1120
170
1200
1110
1230
X TRAVEL
AXIS
LOGIC
CONTROLLER
108

FIG. 20

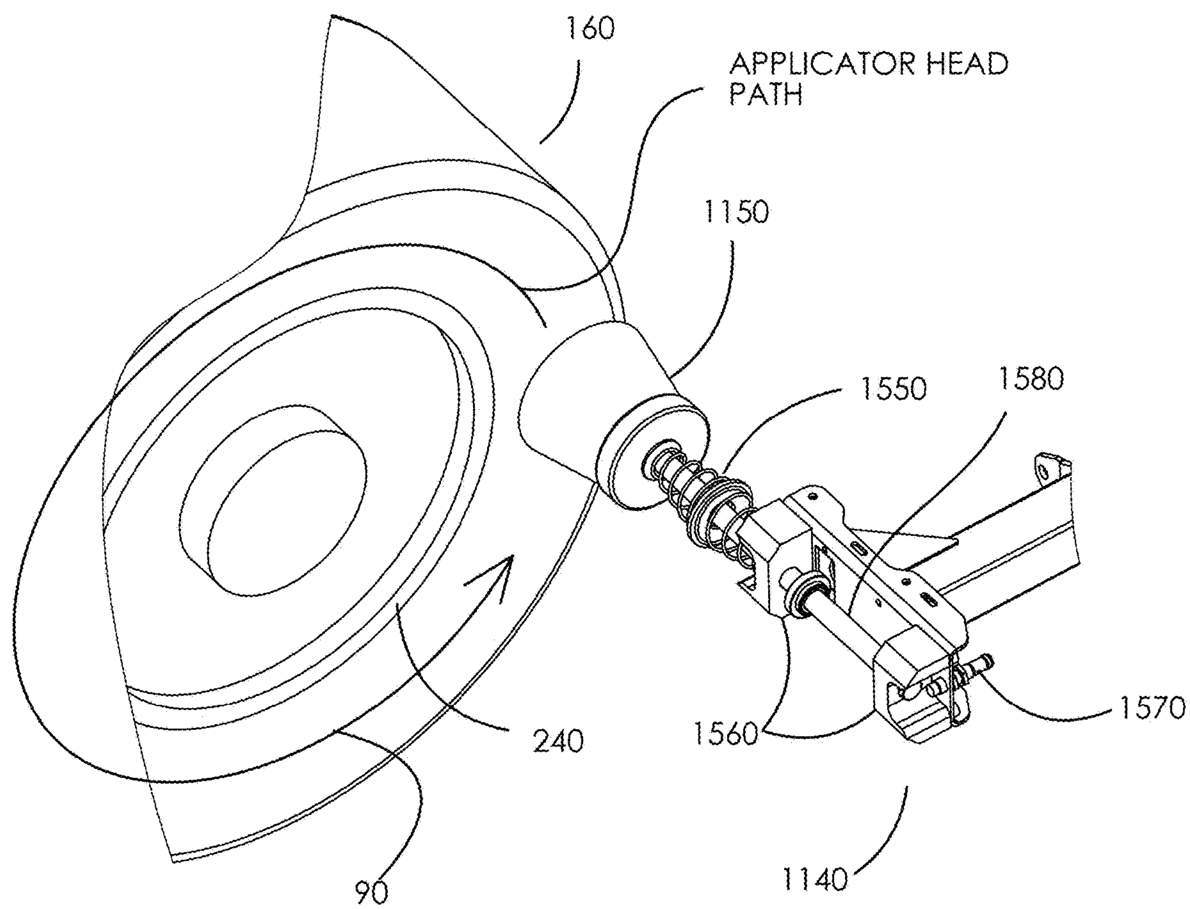

160
APPLICATOR HEAD PATH
1150
1550
1580
1570
1560
240
1140
90

FIG. 21

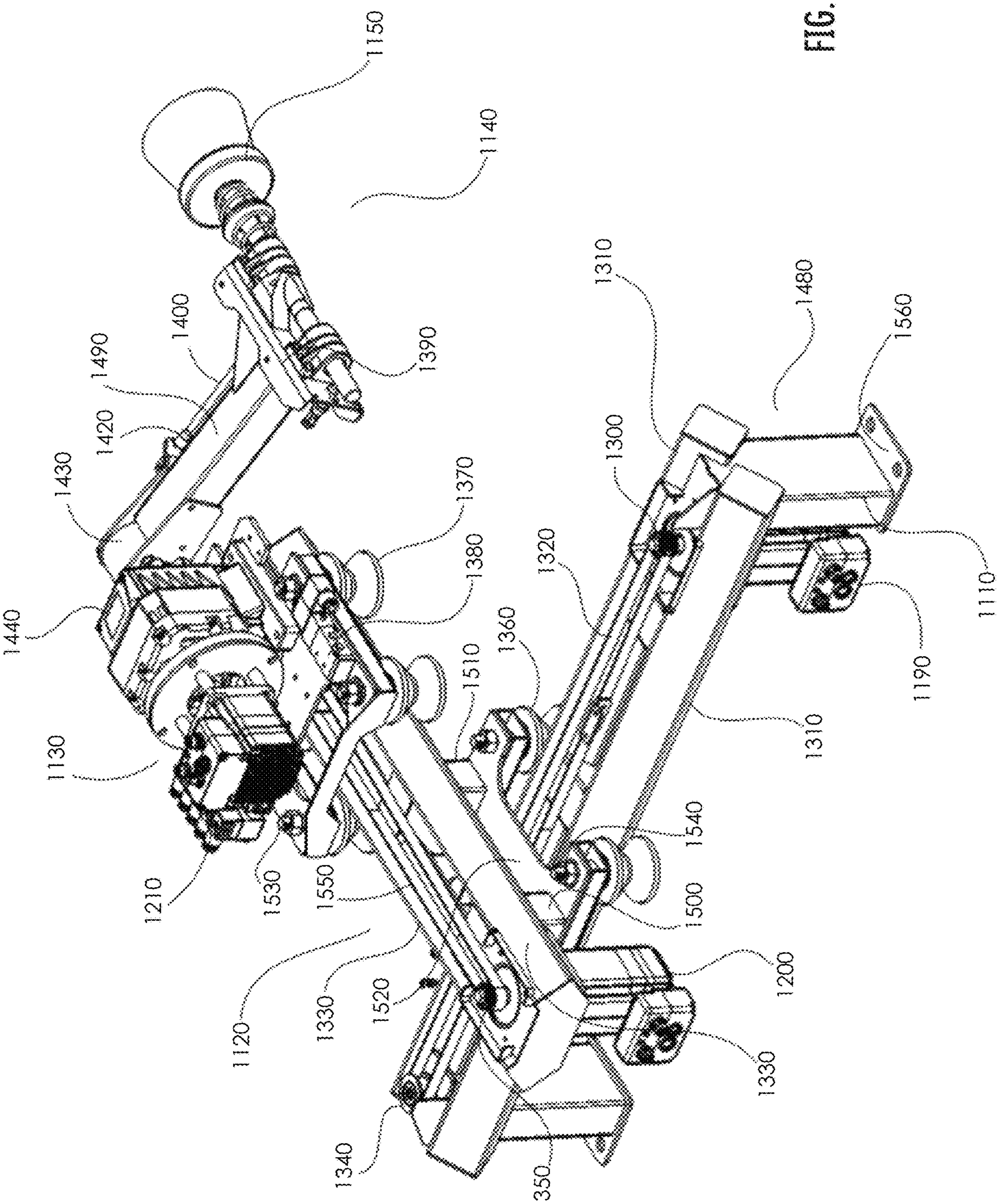

1150
1140
1310
1480
1560
1400
1490
1390
1420
1430
1300
1370
1320
1380
1440
1360
1510
1110
1190
1310
1130
1540
1210
1530
1550
1500
1200
1120
1330
1520
1330
1340
350

FIG. 22

TIRE DRESSING MACHINE AND APPLICATION METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from U.S. provisional patent application No. 62/504,314, filed on May 10, 2017, in the United States Patent and Trademark Office. The disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates to an automated vehicle tire dressing machine and application method, more particularly, to a machine and a method for applying a tire dressing to an exterior tire wall(s) of a vehicle tire as a vehicle is driven through a carwash bay or tunnel.

BACKGROUND OF THE INVENTION

Tire dressing is typically a chemical product applied to a surface of a vehicle tire to provide an attractive shine and protective coating. A tire dressing machine typically operates by spraying a liquid tire dressing onto the tire with a pressurized mist or by a saturated media contact transfer as the vehicle passes by the machine.

The media contact transfer method is the most common of the methods utilized in the professional car detailing industry. A chemical pump or a reservoir dispenses the tire dressing chemical onto an open-cell roller, a bristle brush, or a pad type transfer media. The transfer media may be rotationally powered or even static. The misting spray method generally uses a bar of some type in fluid communication with a chemical pressure pump and that simply sprays the tire as its passes by the apparatus.

Both approaches have distinct disadvantages. The spray type does not apply the dressing in a very accurate or controlled manner. The tire dressing chemical mist therefore ends up on the wash bay floor as a slippery hazard, or even may get pulled into nearby vehicle drying blowers and then be redeposited on the paint surfaces generally as an undesirable oily type film on the vehicle. Therefore, manufacturers have endeavored to avoid this problem by using the aforementioned media contact transfer method. Of the various designs, the most common is a long cylinder shaped applicator that either spins with applicator brushes or slowly rotates with foam rollers as the tires push into the rollers. The spinning brushes cause unwanted misting and disposition onto the car and floor, and the foam rollers become damaged due to the friction and irregular features on many tires. Both designs cannot distinguish between low profile tires, small tires or large tires, and end up applying much of the tire dressing chemical to the tire rims as well or may not apply adequate dressing to a large profile tire. This is wasteful, causes running or "sling" and may require some manual cleanup or touchup. Additionally, these transfer application rollers are generally mounted close to the floor and require the tire to take a full revolution to transfer dressing to the circumference of the tire wall. This means that to properly apply dressing on a 35 inch diameter tire could require 109 inches of linear space, not including additional angular swing in distance from retract position to vehicle tire contact.

The tire dressing machine and application method of the present invention is designed to overcome these disadvantages.

SUMMARY OF THE INVENTION

The present invention generally relates to a tire dressing machine and application method.

In an embodiment of the invention, a vehicle tire dressing machine comprises a longitudinal linear guide system and a lateral linear guide system. The longitudinal linear guide system is adjacent and parallel to a transport conveyor for a vehicle having a vehicle tire. The longitudinal linear guide system has a drive motor and is adapted for reciprocal motion thereon. The longitudinal linear guide system is operably connected to a logic controller. The lateral linear guide system is mounted upon and transverse to the longitudinal linear guide system. The lateral linear guide system has a shuttle mounted thereon and is adapted for linear reciprocal motion. The shuttle has a movable arm assembly with a motor mounted thereon. The movable arm assembly is operable to rotate to various positions and to elevate an applicator head about the vehicle tire.

In an embodiment of the invention, a vehicle tire dressing machine comprises a coordinated motion control system having at least one axis of linear motion and at least one axis of angular motion, and an applicator head coordinated with the coordinated motion control system. The applicator head may have counter-rotating brushes and is operable to contour the vehicle tire.

In an embodiment of the invention, a vehicle tire dressing machine comprises a coordinated motion control system with at least one axis of linear motion and at least one axis of angular motion, and an applicator head coordinated with the coordinated motion control system. The applicator head is operable to contour the outer portion of a tire wall and separately contour the tire wall adjacent to the wheel rim.

In an embodiment of the invention, a system comprises a sensor mounted adjacent to a transport conveyor for a vehicle having a vehicle tire. The sensor detects the presence of the vehicle tire and is operably connected to at least one motor. The sensor moves across a chord of the vehicle tire, and a logic controller in communication with the sensor is operable to calculate the diameter of the vehicle tire from the chord length. A metal detecting sensor directed toward the tire is operable to detect the tire rim and send a signal to the logic controller. The logic controller calculates the rim size. A tire dressing applicator head is operable to circumferentially sweep and shine the vehicle tire separately from the tire rim.

In an embodiment of the invention, a system comprises a sensor mounted adjacent to a transport conveyor for a vehicle having a vehicle tire, a logic controller in communication with the sensor, and a vehicle tire dressing machine in communication with the logic controller. The sensor is operably connected to at least one motor and is movable across a chord of the vehicle tire.

The present invention allows for precision tire wall dressing application regardless of tire size, tire profile, or rim profile. Among the advantages of the tire dressing machine of the present invention is that it reduces waste and manual touchup, reduces overspray hazards, and even reduces the amount of space required in a carwash bay or tunnel to carry out automatic dressing application.

Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiments of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, which are not necessarily to scale, wherein:

FIG. **1** is an isometric view of a tire dressing machine in accordance with the present invention.

FIG. **2**A is a partial isometric view illustrating the applicator head of FIG. **1** in a home position.

FIG. **2**B is a partial isometric view illustrating the applicator head of FIG. **1** in another position.

FIG. **3** is an enlarged isometric view of the tire dressing machine of FIG. **1**.

FIG. **4** is a partial enlarged isometric view of an arm effector attached to an arm assembly of the tire dressing machine.

FIG. **5** is an illustration of tire dressing machine (robot) cycling in accordance with the present invention.

FIG. **6** illustrates the tire dressing machine (robot) receiving a function call from a tunnel controller in accordance with the present invention.

FIG. **7** illustrates step one in which a radar sensor detects tire break and scans to the left.

FIG. **8** illustrates step two of measuring tire rim diameter.

FIG. **9** illustrates a brush path on the vehicle tire.

FIG. **10** illustrates step three of sweep and shine inner wall.

FIG. **11** illustrates step four of shift tire dressing machine (robot) left and swing arm.

FIG. **12** illustrates step five of shine outer tire diameter.

FIG. **13** illustrates step six of finish out last inner tire segment.

FIG. **14** illustrates a variation of a robot arm effector in accordance with the present invention.

FIG. **15** is an isometric view of a tire dressing machine in an embodiment of the invention next to a transport conveyor such as for use in a carwash tunnel.

FIG. **16** illustrates the tire dressing machine of FIG. **15** from a front perspective as a vehicle approaches the tire dressing machine and illustrates sensor arrangement and control logic operation.

FIG. **17** illustrate the tire dressing machine of FIG. **15** and pivot points allowing the tire dressing machine to articulate.

FIGS. **18**A and **18**B illustrate how an effector head of the tire dressing machine of FIG. **15** expands and contracts to accommodate and process vehicle tires of varying diameters.

FIG. **19** is a detailed isometric view of an eye sizing assembly of the tire dressing machine of FIG. **15**.

FIG. **20** is an isometric view of the tire dressing machine of FIG. **15** as installed in a carwash tunnel next to the transport conveyor.

FIG. **21** is a cropped isometric view illustrating an applicator head path on a vehicle tire.

FIG. **22** is a detailed isometric view of the mechanicals of the tire dressing machine of FIG. **15**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description of the embodiments of the present invention is merely exemplary in nature and is in no way intended to limit the invention, its application, or uses. The present invention has broad potential application and utility. The following description is provided herein solely by way of example for purposes of providing an enabling disclosure of the invention, but does not limit the scope or substance of the invention.

FIG. **1** is an isometric view of a tire dressing machine (also referred to herein as a robot) **10** next to a transport conveyor **17** for use, for example, in a carwash tunnel. A vehicle tire **16** moves on transport conveyor **17** and in front of tire dressing machine **10**, preferably moving in a single direction. Vehicle tire **16** has a tire wall **9**. Motors **19**, **20**, **21** and **22**, preferably servomotors, are operably connected to and controlled by a logic controller **8** in their respective axis of motion. Motor **19** shifts a lateral (Z-travel axis) frame **12** along longitudinal (X-travel axis) frame **38** having vertical end posts **11** (see FIGS. **1** and **3**), so as to follow vehicle tire **16**, as vehicle tire **16** travels along transport conveyor **17**. Motor **20** expands tire dressing machine **10** towards vehicle tire **16** during a tire dressing application by linearly actuating a shuttle **13**, mounted on Z-travel axis frame **12**, until an applicator head **15** is in position and then motor **20** retracts shuttle **13** to a home position away from vehicle tire **16** when tire dressing machine **10** is not in use. Motor **21** rotates an arm assembly **14** about a Theta A axis to raise and lower applicator head **15** as needed according to the tire diameter and height. Motor **22** rotates applicator head **15** about a Theta B axis to position applicator head **15** in an optimum orientation for dressing vehicle tire **16**. Additionally, at least one laser sensor **18** is coupled to applicator head **15** such that laser sensor **18** detects vehicle tire **16** and/or any gap around vehicle tire **16** (such as between a vehicle fender well and vehicle tire **16**) as well as detects the need for logic controller **8** to adjust the position of tire dressing machine **10** accordingly. Alternatively or in conjunction, a rotational laser scanning sensor **23** sweeps the profile of vehicle tire **16** continuously as vehicle tire **16** travels down transport conveyor **17**. Rotational laser scanning sensor **23** measures the size of vehicle tire **16** by scanning along a tire chord of vehicle tire **16** so logic controller **8** can calculate the diameter of vehicle tire **16**. Rotational laser scanning sensor **23** also tracks the progress of vehicle tire **16** in transport conveyor **17**. It should be noted that logic controller **8** is programmed such that it can maintain a linear-circular relationship between the X-axis, Theta A axis, and Theta B axis to maintain coordinated motion in a coordinated motion control system causing applicator head **15** to follow the contour of the tire wall **9** during the tire dressing application.

FIGS. **2**A and **2**B are partial isometric views showing applicator head **15** in two different positions by actuating a pneumatic rotary actuator **26**. FIG. **2**A shows applicator head **15** in a home position which orients a high powered inductive proximity switch **25** toward vehicle tire **16**. As part of the initial tire measurement laser scanning, tire dressing machine **10** sweeps proximity switch **25** across the tire profile and proximity switch **25** detects a metal tire rim **24** by an inductive electromagnetic field **27**. Inductive proximity switch **25** sends a signal to logic controller **8**, and logic controller **8** records the rim size in relationship to the vehicle tire. Tire dressing machine **10** then positions applicator head **15** next to metal tire rim **24** as shown in FIG. **2**B and sweeps applicator head **15** around metal tire rim **24** and along the tire wall inner section.

FIG. **3** is an enlarged isometric view of tire dressing machine **10**. A longitudinal (X-travel axis) frame **48** has two elongated square tubings **31** that serve as structural and guide elements for tire dressing machine **10** and are supported at distal ends by two vertical end posts **11** that elevate the track and provide clearance for motor **19**. End posts **11** have flange plates **56** welded onto the bottom of end posts **11** to anchor tire dressing machine **10** to a floor. Lateral (Z-travel axis) frame **12** is mounted transverse and upon longitudinal (X-travel axis) frame **48** by four plastic V-rollers **36** that tightly guide lateral (Z-travel axis) frame **12** on the X-axis frame tubings **31**. Lateral (Z-travel axis) frame **12** is reciprocally driven back and forth by motor **19** mounted into longitudinal (X-travel axis) frame **48** at one end, a drive pulley **30** secured onto the motor drive shaft, and a timing belt **32** driven by drive pulley **30** and wrapped around an idler pulley **34** at an opposite end of longitudinal (X-travel axis) frame **48**.

Lateral (Z-travel axis) frame **12** is a weldment having two elongated square tubings **33** which are supported and spaced apart by tubing standoffs **50** and **51**. Tubing standoffs **50** and **51** are terminated at bottom ends by lateral (Z-travel axis) frame base plate **52**, which has holes, preferably four, through which idler axles **54** are bolted, concentrically securing V rollers **36** for rotational movement.

Shuttle assembly **13** has a base plate **38** having a top face with clearance holes therein whereby a suitable gearbox **44** is bolted to the top face. An output shaft of gearbox **44** extends outward toward the vehicle tire and is adapted for mounting arm assembly **14** onto it for rotational actuation of arm assembly **14**. Gearbox **44** input is driven by motor **21** which is secured to the input face by a coupler or spline type of connection. Shuttle assembly **13** is actuated for linear reciprocal movement toward and away from vehicle tire **16** by motor **20** mounted to lateral (Z-travel) axis frame **12** at one end and motor having a timing pulley **35** secured onto the end of lateral (Z-travel axis) frame **12** for driving a timing belt **55**. At the other end of timing belt **55**, an idler pulley is mounted to lateral (Z-travel axis) frame **12** to support the other end of timing belt **55** for rotational movement. A timing belt clamp on the bottom of baseplate **38** locks onto timing belt **55**. Additionally, downward extending idler shafts **53**, preferably four, are secured into baseplate **38**, securing V-rollers **37** so as to locate shuttle assembly **13** to lateral (Z-travel axis) frame **12** for linear reciprocal motion thereupon.

Arm assembly **14** comprises an elongated square tube **49** with flanges at the rotational driving end to house a machined shaft coupling **43** which tightly locks arm assembly **14** onto the end of drive gearbox **44**. At the distal end of arm assembly **14**, several compliant, elastic isolation mounts **39** allow connection of an arm effector **46** with applicator head **15** at the end without a rigid mechanical connection. This allows for potential vehicle impacts or cycle failures without damaging tire dressing machine **10**. Elastic isolation mounts **39** give in all force applied directions and indicator rod **40** along with a proximity sensor **42** separate when this happens and send a signal to logic controller **8**, thereby detecting the impact.

FIG. **4** is a partial enlarged isometric view of arm effector **46** attached to arm assembly **14**. A welded base chassis **67** is constructed such that it houses motor **22** and connects to arm assembly **14** by the isolation mounts **39**. Additionally, chassis **67** is mounted to the motor by being sandwiched between the motor and a gearbox **45**. A strong and lightweight assembly keeps the moment of inertia lower than many other attachment methods.

Applicator head **15** is an assembly controlled in order to rotate about the Theta B axis; however, applicator head **15** is also operable to pivot about Theta C axis as actuated by a pneumatic rotary actuator **64** such that applicator brushes **61** and **62** can be stored away from the vehicle and exposing inductive sensor/proximity switch **25** during wheel rim measurement. Pivot block **65** is clamped into gearbox **45** and retains a set of suitable bearings for the pivotal motion as well. A pivot pin included as part of base chassis **67** allows the rotational connection of applicator head **15** to pivot block **65** and gearbox **45**. Base chassis **67** preferably has applicator brushes **61** and **62** mounted to base chassis **67** by a suitable double bearing arrangement and applicator brushes **61** and **62** being driven by motor **66** in a counter-rotating motion. A swabby type of applicator brush may be added on the end of the robot and it may expand outward. A double sided serpentine timing belt **63** is driven by motor **66**, and a series of idler pulleys fits timing belt **63** around the brush drive pulleys to provide counter-rotating motion. The advantage of such counter-rotating motion, specifically from outside to inside as the brushes contact the tire, is that the tire wheel dressing has a tendency to sling inward toward the opposing brush rather than outward on one side as would happen with a single brush thereby causing significant undesirable misting of the tire dressing.

In accordance with the present invention, a tire dressing application method is provided. Variations to the method may be made yet still be within the scope of the present invention.

FIG. **5** is an illustration of tire dressing machine (robot) cycling in accordance with the present invention.

FIG. **6** illustrates the tire dressing machine (robot) receiving a function call from a tunnel controller in accordance with the present invention.

FIG. **7** illustrates step one in which as soon as a radar sensor detects a tire break, the robot moves to the left and scans the tire diameter. The tire size is stored into computer memory.

FIG. **8** illustrates step two of measuring rim diameter. The robot flips the applicator head 180 degrees, moves to the calculated tire centerline, moves in a distance (such as approximately one half inch away from the wheel) and then drops the inductive proximity switch until it sees the last trailing edge signal.

FIG. **9** illustrates an applicator brush path on the vehicle tire.

FIG. **10** illustrates step three of sweep and shine inner wall.

FIG. **11** illustrates step four of shift tire dressing machine (robot) left and swing arm. At this point the robot will be out of room on the right side. The applicator head of the robot will back out, swing clockwise from eight o'clock to 4 o'clock position while moving the robot to the left.

FIG. **12** illustrates step five of shine outer tire diameter. At the end of the move, the robot will be just following the contour of the vehicle tire as it comes out of the conveyor on the driver side.

FIG. **13** illustrates step six of finish out last inner tire segment. After finish, the robot moves to step one position or the home position.

In an embodiment of the invention, the robot arm effector does not require any motors and/or an inductive proximity switch/sensor as shown in FIG. **14**.

In an embodiment of the invention, another configuration of a tire dressing machine is provided.

FIG. **15** is an isometric view of a tire dressing machine **200** comprising a longitudinal linear guide system and a lateral linear guide system. Tire dressing machine **200** is next to a transport conveyor **170** such as for use in a carwash tunnel. A vehicle tire **160** rolls on transport conveyor **170** in front of the tire dressing machine, preferably moving in a single tire travel direction. Vehicle tire **160** has a tire wall **90** (shown in FIG. **16**) with a leading edge **160**A and a trailing edge **160**B. A logic controller **80** controls motors **260** and **640**, preferably servomotors, in their respective axis of motion. Motor **260** shifts the tire dressing machine along a X-travel axis, so as to follow vehicle tire **160** as vehicle tire **160** travels along transport conveyor **170**. During the application process, motor **640** actuates an elevator roller assembly **610** downward. Elevator roller assembly **610** has an upper pivot point **570** pivotably connected to an upper linkage **500** and a lower pivot point **580** pivotably connected to a lower linkage **510**. Both linkages are approximately the same length and are similarly connected to an effector link assembly **620** (shown in FIG. **17**) having upper and lower pivot points **550** and **560**. The pivotable connection between assemblies **610** and **620** with linkages **500** and **510** form what is referred to as a four-bar-link, which maintains the vertical orientation of effector link assembly **620** relative to the vertical orientation of elevator roller assembly **610** during operation. In the center of lower linkage **510**, pivot point **590** connects one end of control arm **520** and the other end of the control arm is pivotably connected to pivot point **600**. Control arm **520** is half the length of linkage **510** and pivot point **600** is the same elevation as pivot point **560**. Pivot point **600** is also directly below pivot point **580**. Elevator roller assembly **610** is pivotably connected to linkage **510** and control arm **520** in an arrangement referred to as a Scott Russell mechanism, such that when elevator roller assembly **610** is actuated downward, an applicator end expander head assembly **450** is actuated linearly and horizontally toward vehicle tire **160**.

As shown in FIGS. **16** and **17**, it is advantageous that tire dressing machine **200** may occupy a very narrow space laterally while not in operation and at a home position, and yet have a great deal of straight-line lateral horizontal extension. This is shown in FIG. **17** as a home retracted distance of L, and a potential extended distance of greater than L*2. When returning to home position after a cycle, logic controller **80** actuates elevator roller assembly **610** to the top of the tire dressing machine, thereby retracting applicator heads **400** to a home position away from the vehicle tire. Ultrasonic sensors **310**A and **310**B detect the presence of vehicle tire **160** and the distance of vehicle tire **160** to the sensors as vehicle tire **160** rolls into a tire dressing machine area or station, and ultrasonic sensors **310**A and **310**B send analog signals to logic controller **80**. For many vehicles, there is a gap between the fenderwell and/or ground effects and the vehicle tire. Logic controller **80** detects such a gap when photosensor eyes **300**C and **300**D respectively have a clear detection of a reflector **350**. This is translated as an "ON" condition for each respective sensor. Subsequently, as the vehicle tire progresses, photosensor eye **300**C will become blocked by the vehicle tire which is translated as an "OFF" condition, and photosensor eye **300**D will remain "ON" as photosensor eye **300**D detects reflector **350**. Logic controller **80** moves tire dressing machine **200** along the X-travel axis at a velocity so as to follow leading edge **160**A of vehicle tire **160** by monitoring with photosensor eyes and by adjusting the velocity of the tire dressing machine accordingly. As soon as leading edge **160**A is detected, logic controller **80** causes a photoeye array adjustment unit (not shown) to contact a trailing set of photosensor eyes **300**A and **300**B closer to the leading edge photosensor eyes **300**C and **300**D until photosensor eye **300**A is "ON", photosensor eye **300**B is "OFF", interpreted as vehicle tire trailing edge detection. At this point in the operation, the tire dressing machine is locked onto the velocity and approximate tire diameter. Correspondingly, logic controller **80** causes expander head assembly **450** to adjust position of applicator heads **400** to the size of the tire diameter of vehicle tire **160**. By actuation and kinematics, expander head assembly **450** is pushed towards vehicle tire **160** and applicator heads **400** apply a tire dressing chemical to tire wall **90**.

FIGS. **18**A and **18**B illustrate how expander head assembly **450** of FIG. **17** expands and contracts to accommodate and process vehicle tires of varying diameters. Logic controller **80** controls a motor **470**, preferably a servomotor, having a first timing pulley **420** attached and thereby driving a timing belt **460**. A second timing pulley **430** is used to give the motor drive adequate gear reduction. Second timing pulley **430** is constrained rotationally to drive a shaft **780**A. Drive shaft **780**A intermeshes with an intermediate drive shaft **780**B at a 90 degree angle to each other and housed in a housing **480** and are drivenly connected by bevel gears **410**. Both drive shafts have respective expander arms **360**A and **360**B mounted thereon and are timed in a general mirror image to each other in their actuation with expander head assembly **450** on each end. This allows the tire dressing machine to drive applicator heads **400**A and **400**B at 45 degrees from horizontal and vertical centerplanes of the vehicle tire. This configuration of the tire dressing machine is positioned such that motor **470** operates in a selected direction, the applicator heads **400** will either expand and raise, or contract and lower, to match the horizontal centerline and diameter of vehicle tires of varying dimensions. As the tire moves and rotates through the tire dressing station, the applicator pads/rollers of applicator heads **400** will maintain positions at the leading edge tire position **160**A and trailing edge tire position **160**B at the horizontal centerline while applying a dressing chemical to tire wall **90**. With the applicator heads located opposite each other, vehicle tire **160** can be processed in 180 degrees of motion. One applicator head provides for an upper side coverage, the other applicator head provides for a lower side coverage.

Tire dressing machine **200** also utilizes a four-bar-link kinematic arrangement in conjunction with each applicator pad/roller **800** so as expander arms **360**A and **360**B are actuated, the applicator heads maintain an orientation that is normal to the tire wall allowing pads/rollers **800**, spray manifold **490**, and wipers **810** to maintain a preferred angle of approach. Located in housing **480** additionally, are two more rotationally driven shafts **370**. One shaft is parallel to drive shaft **780**A and another shaft is parallel to drive shaft **780**B. At a lower end of each of drive shafts **370** are expander arms **360**A and **360**B rotational keyed to the drive shafts and pivotably secured into clevis links **820**. The expander arms **360**A and **360**B are also pivotably connected to the each end of clevis links **820** having clevis pins **830** and which together act as four-bar links to actuate the applicator heads.

Expander head assembly **450** is designed to somewhat float on the end of tire dressing machine **200** so as to keep impacts during operation to a minimum. Therefore, expander housing **480** is connected to tire dressing machine **200** by support shafts **390** located into a bearing block **790** allowing for linear movement by expander head assembly **450**. Coil springs **380** maintain a compliant bias force between tire dressing machine **200** and expander head assembly **450** so when tire dressing machine **200** pushes expander head assembly **450** against the vehicle tire then expander head assembly **450** can float accordingly. It should be noted that those familiar with robotics and general machinery would recognize that even though not all explicitly shown herein, suitable bearings and bushings would be used where required throughout the design.

FIG. **16** shows tire dressing machine **200** from a front perspective as a vehicle **210** approaches tire dressing machine **200** and illustrates sensor arrangement and control logic operation. Sensors **300**A, **300**B, **300**C and **300**D are mounted in parallel at a generally 20 degree angle to the floor, and emit respective photobeams **320**A, **320**B, **320**C and **320**D toward reflector **350**. Reflector **350** is mounted inside of vehicle transport conveyor **170** and low enough to not damage or be damaged by the bottom of vehicle **210**. The photobeams are located to detect any open area between potential ground effects **220** and vehicle tire **160** and detect at least a portion of vehicle tire **160** high enough to give a rough diameter of the vehicle tire. The tire diameter is calculated from multiple points, preferably 3 points, on a circle, and the circle translating to the vehicle tire. One point is the bottom of the vehicle tire where the vehicle tire touches the ground. Two other points are at the leading edge **160**A and trailing edge **160**B of the vehicle tire, whereby a circle chord is measured between these two points. Since the photobeams are at an angle, and the tire wall will be a different distance from the tire dressing machine. The vehicle tire distance is measured by ultrasonic analog sensors **310**A and **310**B. Using a distance measurement, logic controller **80** calculates the height at which the leading edge photobeams at the leading edge and photobeams at the trailing edge are broken to give the position of the chord point measurement and a tire diameter for processing.

FIG. **19** is a detailed isometric view of eye sizing assembly **900**. A channel chassis **910** has termination caps **990** at its distal ends to receive linear guide shafts **920** arranged in parallel to each other and to the chassis. Linear bearing blocks **930**A and **930**B have precision clearance holes therein and are able to receive the linear guide shafts. Motor **950** controlled by logic controller **80** is secured into an end of the chassis and has timing drive pulley **960** mounted onto the chassis. At opposite ends of the chassis, a timing idler pulley **970** is suitably mounted into the chassis with rotationally free movement. A timing belt **980** spans across the chassis and wraps around timing drive pulley **960** and timing idler pulley **970**. One side of timing belt **980** connects to one of bearing blocks **930**A or **930**B, and the other side of the timing belt connects to the other of bearing blocks **930**A or **930**B so when motor **950** rotates clockwise it causes bearing blocks **930**A and **930**B to move inward toward each other and when it rotates counter-clockwise it causes bearing blocks **930**A and **930**B to move away from each other. One of the bearing blocks has leading edge photoeyes **300**C and **300**D mounted to the bearing block by bracket **940**, and the other bearing block **930** has trailing edge photoeyes **300**A and **300**B mounted to the bearing block by a bracket **940**. In this way, logic controller **80** causes the leading set of eyes and the trailing set of eyes to expand and contract according to the size of the vehicle tire being measured. Termination caps **990** close out the chassis and secure linear guide shafts **920**.

Referring back to FIG. **15** and FIG. **17**, these figures illustrate tire dressing machine and pivot points allowing the tire dressing machine to articulate accordingly. Tire dressing machine **200** sits upon and is guided by a longitudinal linear (X-travel axis) guide system/frame assembly **250**. An elongated metal tubing **680** lies parallel to vehicle transport conveyor **170** and has vertical risers **690** welded to each of its distal ends thereby elevating tire dressing machine **200** off the wash bay floor. Each vertical riser **690** has a termination plate **700** welded to a lower end which allows the tire dressing machine to be anchored into the wash bay floor. At one end of tubing **680**, a motor **260**, preferably a servomotor, is mounted to the X-travel axis frame assembly **250** by a mounting bracket (not shown). Motor **260** having a timing drive pulley **290** secured to motor **260** and at the opposite end of the tubing a timing idler pulley **280** is mounted to the frame assembly **250** by a bracket and bearings (not shown) for free rotational movement. A timing belt **270** is wrapped around pulleys **290** and **280** spans along the length of the tubing.

Tire dressing machine **200** is connected to timing belt **270** which allows motor **260** to actuate the tire dressing machine along the X-travel axis. The tire dressing machine **200** has a vertical framework that is comprised of spaced apart elongated linear tubings **530** and **540** that are arranged in parallel and welded to an upper termination cap **490** and a lower termination plate **750**. Structural reinforcements **760** and **770** may be welded onto the vertical framework. This framework is welded to a base tubing **740** having vertical tubings **710** at each end. Vertical tubings **710** accept travel idler shafts **730** which in turn, accept idler wheels **720**. Idler wheels **720** are located top and bottom of X-frame tubing **680** and tightly guide the tired dressing machine for linear reciprocal motion thereupon. Approximately in the middle of the tire dressing machine, motor **640** is mounted on an end of tire dressing machine **200** with timing pulley **650** secured onto the end. On the upper end of tire dressing machine **200**, idler timing pulley **670** is located with timing belt **660** wrapped around timing pulley **670**. Timing belt **660** is driven by timing pulley **650**.

A Scott Russell mechanism is formed by bar links **510** and **520**, and a sliding elevator mechanism **610**. Elevator mechanism **610** is a weldment having an upper set of guide rollers **630**A and a lower set of guide rollers **630**B which are controlled and guided within vertical tubings **530** and **540** of tire dressing machine **200**. Elevator mechanism **610** has an integral pivot point **580** connecting main extension bar link **510** on one end. Main extension bar link **510** is pivotably connected to extension head link **620** on the other end and has pivot point **590** at the center of the main extension bar link. Rotational control short links **520**A and **520**B are pivotably connected at a center point and are also pivotably connected to the tire dressing machine at pivot **600**. Elevator mechanism **610** is connected to elevator timing belt **660** such that when motor **640** rotates, elevator mechanism **610** raises or lowers and articulates the Scott Russell mechanism and expander head assembly **450** extends or retracts in a straight line accordingly.

Additionally, the four-bar-link mechanism formed by joining links **610**, **500**, **510** and **620** with pivot points **550**, **560**, **570** and **580** in conjunction with the Scott Russell mechanism causes expander head assembly **450** to remain in parallel.

FIG. **20** is an isometric view of the tire dressing machine **200** as installed in a carwash tunnel next to transport conveyor **170**. Vehicle tire **160** having tire wall **90** and a metal tire rim **240** (shown in FIG. **21**) moves in front of tire dressing machine **200** in a single direction. Logic controller **108** controls motors **1190**, **1200**, and **1210** in their respective motion axis. Motor **1190** shifts tire dressing machine **200** along the X-travel axis, so as to follow the vehicle tire as the vehicle tire travels along transport conveyor **170**. Motor **1200** extends the tire dressing machine into the vehicle tire by linearly actuating a shuttle **1130** until the application head is in position and retracts shuttle **1130** to a home position away from the vehicle when not in use. Motor **1210** rotates the tire dressing arm assembly **1140** about Theta A axis to raise and lower the applicator head (shown as **1150** in FIG. **20**) according to the tire diameter and tire height.

A rotational laser scanning sensor **1230** sweeps a profile of the vehicle tire continuously as the vehicle tire travels down transport conveyor **170**, and measures size of the vehicle tire by scanning across a tire chord. Logic controller **80** calculates the tire diameter. Rotational laser scanning sensor **1230** can track the progress of the vehicle tire in transport conveyor **170**. It should be noted that logic controller **80** is programmed such that it can maintain a linear-circular relationship between the X-travel axis and Theta A axis to maintain coordinated motion that causes the applicator head to follow the contour of the tire wall during the tire dressing application.

FIG. **21** is a cropped isometric view illustrating a path of the applicator head. FIG. **22** is a detailed isometric view of the mechanicals of the tire dressing machine. A longitudinal X-travel axis frame/weldment **1480** has elongated square tubings **1310** that serve as structural and guide elements for the tire dressing machine and are supported at distal ends by vertical end posts **1110** that elevate the track and provide clearance for the X-travel axis motor **1190**. The bottom ends of the vertical end posts have flange plates **1560** welded on to anchor the tire dressing machine to the floor. A lateral linear (Z-travel axis) frame/weldment **1120** is mounted transverse and upon the X-travel axis frame by V-rollers **1360**A, **1360**B, **1360**C, and **1360**D that tightly guide the Z-travel axis frame on the X-travel axis base frame tubings. The Z-travel axis frame is reciprocally driven back and forth by motor **1190** mounted into the X-travel axis frame, a drive pulley **1300** secured onto motor drive shaft **1200**, and a timing belt **1320** driven by the drive pulley and wrapped around idler pulley **1340** at the opposite end of the X-travel axis frame assembly **250**. When the applicator head impacts the tire, support shaft **1580** (shown in FIG. **21**) slides through flange plates **1560** and is pushed in front of a proximity switch. The proximity switch sends a signal to logic controller.

The Z-travel axis frame **1120** is a weldment having elongated square tubings **1330** which are supported and spaced apart by tubing standoffs **1500** and **1510**. Tubing standoffs **1500** and **1510** are terminated at bottom ends by Z-travel axis frame base plate **1520**. Idler axles **1540**A, **1540**B, **1540**C, and **1540**D are bolted through and concentrically secure V rollers **1360**.

Shuttle assembly **1130** has a baseplate **1380** with clearance holes in the baseplate whereby a gearbox **1440** is bolted to a top face of the baseplate, a gearbox output shaft **1430** extending outward toward the vehicle and adapted for mounting a robotic arm **1140** for rotational actuation of the robotic arm. The gearbox input is driven by a motor **1210** having a coupler or spline type of connection. This assembly is actuated for linear reciprocal movement toward and away from the vehicle by motor **1200** mounted into the Z-travel axis chassis at one end of the chassis and motor **1200** having timing pulley **1350** secured onto the end of the motor for driving timing belt **1550**. At the other end of timing belt **1550** an idler pulley (not shown) is mounted into the Z-travel axis chassis supports the other end of timing belt **1550** for rotational movement. Additionally, downward extending idler shafts **1530**A, **1530**B, **1530**C, and **1530**D are secured into the baseplate, securing V-rollers **1370** so as to locate the shuttle assembly **1130** onto the Z-travel axis chassis for linear reciprocal motion thereupon.

Robotic arm **1140** is an elongated square tube **1490** with flanges at the rotational driving end to house a machined shaft coupling **1430** which locks the robotic arm **1140** onto the end of drive gearbox. At the robotic arm distal end, several isolation mounts **1390** allow the connection of head rotation stage **1460** with the applicator head at the end without a rigid mechanical connection. This allows for potential vehicle impacts or cycle failures without damaging the tire dressing machine. The isolation mounts when elastic give in all force applied directions and an indicator rod **1400** along with a proximity sensor **1420** separate when this occurs and send a signal to logic controller **80**, thereby detecting an impact.

It will therefore be readily understood by those persons skilled in the art that the present invention is susceptible of broad utility and application. Many embodiments and adaptations of the present invention other than those herein described, as well as many variations, modifications and equivalent arrangements, will be apparent from or reasonably suggested by the present invention and the foregoing description thereof, without departing from the substance or scope of the present invention. Accordingly, while the present invention has been described herein in detail in relation to its preferred embodiment, it is to be understood that this disclosure is only illustrative and exemplary of the present invention and is made merely for purposes of providing a full and enabling disclosure of the invention. The foregoing disclosure is not intended or to be construed to limit the present invention or otherwise to exclude any such other embodiments, adaptations, variations, modifications and equivalent arrangements.

What is claimed is:

1. A vehicle tire dressing machine comprising:

a longitudinal linear guide system adjacent and parallel to a transport conveyor for a vehicle having a vehicle tire, the longitudinal linear guide system having a longitudinal frame in a x-travel axis direction, and

a lateral linear guide system having a lateral frame in a z-travel axis direction,

wherein the longitudinal linear guide system has a drive motor for shifting the lateral linear guide system along the longitudinal linear guide system, wherein the lateral linear guide system has a shuttle mounted on the lateral frame of the lateral linear guide system, the shuttle having a baseplate with a top face and a drive gearbox mounted to the top face of the baseplate and a rotatable arm mounted onto an end of the drive gearbox, the shuttle movable in the z-travel axis direction, wherein the shuttle is configured to move along the lateral frame of the lateral linear guide system relative to the lateral frame, and wherein the drive gearbox is configured to cause the shuttle to move in the z-travel axis direction relative to the lateral frame.

2. The vehicle tire dressing machine according to claim **1**, wherein the longitudinal linear guide system is adapted for reciprocal motion.

3. The vehicle tire dressing machine according to claim **1**, wherein the tire dressing machine is operably connected to a logic controller.

4. The vehicle tire dressing machine according to claim **1**, wherein the lateral linear guide system is mounted upon and transverse to the longitudinal linear guide system.

5. The vehicle tire dressing machine according to claim **1**, wherein the lateral linear guide system is adapted for linear reciprocal motion.

6. The vehicle tire dressing machine according to claim **1**, wherein the rotatable arm is movable with a motor.

7. The vehicle tire dressing machine according to claim **1**, wherein the shuttle is operable to rotate in various positions.

8. The vehicle tire dressing machine according to claim **1**, wherein the shuttle is operable to elevate an applicator head about the vehicle tire.

9. The vehicle tire dressing machine according to claim **1**, further comprising an elevator roller assembly.

10. The vehicle tire dressing machine according to claim **9**, wherein the elevator roller assembly has an upper pivot point pivotably connected to an upper linkage and a lower pivot point pivotably connected to a lower linkage.

11. The vehicle tire dressing machine according to claim **10**, wherein the upper linkage and the lower linkage are connected to an effector link assembly having an effector link upper pivot point and an effector link lower pivot point.

12. The vehicle tire dressing machine according to claim **11**, wherein the effector link assembly has a vertical orientation relative to a vertical orientation of the elevator roller assembly.

13. The vehicle tire dressing machine according to claim **10**, wherein the lower linkage connects to a control arm.

14. The vehicle tire dressing machine according to claim **13**, wherein the elevator roller assembly is pivotably connected to the lower linkage and the control arm.

15. The vehicle tire dressing machine according to claim **9**, wherein the elevator roll assembly is movable in a downward direction.

* * * * *